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THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 20 JANUARY, 1922 No. 1

TWO INTERESTING CASES OF ECTROSYNDACTYLY [1]

By S. E. YAP and E. V. PINEDA

Of the Departments of Anatomy and Pathology and Bacteriology, College of Medicine and Surgery, University of the Philippines

SIX PLATES

The deformities discussed in this paper consist of ectrodactyly and syndactyly. The former is a defect of the extremities in which there is absence of digits, and the latter is the condition where there is coherence of digits. Both of these malformations were found associated in our two cases.

Ectrosyndactyly is of embryological interest, though it has received but little attention until lately. It is interesting from the viewpoint of its origin and occurrence. Its close resemblance to the claw of the crab or the hoof of some of the ungulates at once attracts the observer's attention. Brief and scattered records of this deformity can be found in the literature of the latter part of the nineteenth century. But there are some cases reported as early as the seventeenth century; such, for instance, as the "Cleppie Bells" family mentioned by Pearson. It is interesting to mention in this connection that the deformity seems to be common in Scotland, where it has been traced in families through from four to six generations. In the majority of cases the defect has occurred in families. Of one hundred eighty cases, collected by Lewis and Embleton in 1907 from the literature, only thirteen occurred as single cases; that is, in various families.

It is unfortunate that we had to base our observations upon only external examination of the extremities and a study of

[1] Read before the annual meeting of the Philippine Islands Medical Association, February 2, 1921.

skiagrams. Permission to dissect was refused in Case I, and in Case II, which is still living, it was of course out of the question. The study of skiagrams alone is not sufficient, nor is it entirely satisfactory unless supplemented by actual dissection, for the reason that the shadows are often so indefinite that one cannot always accurately determine union or separation of bones. Moreover, the soft parts blur the image according to the position of the member at the time of the exposure. This is true of the skiagrams of the tarsus in both cases where no definite idea could be gained from the most careful study of the shadows. Hays reports the finding of partial bony union, after actual dissection, which was definitely indicated as separate in the X-ray picture. In judging the size of bones from X-ray pictures alone, we again court error which may cause considerable discrepancy. There was no alternative in our cases, so we had to do the best we could, under the circumstances, by using articulated adult extremities for comparison and control.

CASE I

A Filipino woman, aged 35 years, brought to the morgue, having died from accidental burns. She appeared well nourished and showed no deformities other than those of the extremities, the description of which follows:

Right hand.—The right hand shows only three digits: the thumb, the ring finger, and the small finger. The thumb is distorted. It seems to show muscular atrophy, with wrinkling of the skin, and tapers to a point, devoid of nail beyond the bone. The ring and small fingers are syndactylized by the soft tissues at their contiguous margins throughout their entire length. Each is provided with a distinct, apparently normal nail. (Plate 1, fig. 1.)

The carpal bones are distinct and complete in number. The greater and lesser multangulars appear displaced distally and laterally, but otherwise the entire carpus seems normal.

The metacarpals are also complete and distinct. The first seems to have been partially disarticulated from the greater multangular, as apparently indicated by a wide gap between the two and by the direction of the axis of the first metacarpal, being pushed decidedly inward, parallel to the bones of the forearm, instead of diverging outward as it would do normally. The second and third are considerably displaced laterad; the second is somewhat smaller than normal. The fourth and fifth are likewise pushed to the medial side, leaving a triangular

space between the third and fourth. The proximal ends of the metacarpals, except that of the second which articulates only with the greater multangular, appear normal in position and connections, while their distal ends or heads show considerable displacement. The head of the second is in contact with that of the first; the heads of the fourth and fifth are also in contact with each other.

The phalanges of the thumb are normal. There are no phalanges in the second metacarpal. The third metacarpal shows only the proximal phalanx considerably lengthened and displaced transversely, wedged in between and articulating with the head of the third and the base of the proximal phalanx of the fourth metacarpal. This phalanx is shaped like a metacarpal, shows evidence of a fracture laterally, and seems to be responsible for the divergence of the third and fourth metacarpals. The phalanges of the fourth and fifth are normal, except for the articulation of the proximal end of the first phalanx of the fourth with the crossed phalanx of the third as mentioned above. (Plate 1, fig. 2.)

Left hand.—The left hand also has three digits, the same as in the right. The ring and small fingers, however, are not syndactylized, and the thumb is apparently normal. (Plate 2, fig. 1.)

The carpals are normal.

The metacarpals are complete and distinct. The first and the fourth are shorter than normal, the second is slenderer and the fifth is larger. The fourth metacarpal curves toward the ulnar side, touches the fifth, and leaves a considerable space between it and the third.

The phalanges of the first metacarpal are normal. The second shows only a rudimentary proximal phalanx, displaced medially. The third has only the proximal phalanx which is bent transversely medially, fusing with the middle of the proximal phalanx of the fourth, and acts as a wedge which pushes the fourth metacarpal toward the ulnar side of the hand. The fourth metacarpal shows a union of the proximal and middle phalanges, the resulting bone being displaced laterally and joined with the proximal phalanx of the third, as mentioned above. The distal phalanx is normal. The last metacarpal also shows a distorted union between its first and middle phalanges, while its distal phalanx is normal. (Plate 2, fig. 2.)

Right foot.—The right foot exhibits only two toes, the great toe and the fifth, each provided with a nail, and with their distal

ends curved toward each other like two claws. There is a deep cleft between the two toes extending down to the metatarsal region. The skin shows considerable wrinkling, not unlike the condition observed when a foot has been under water for some time. (Plate 3, fig. 1.)

The bones of the tarsus are apparently normal, except the cuneiform bones, which are so blurred that it is impossible to determine whether there is fusion between them, or between them and the cuboid. (Plate 3, fig. 2.)

Only the first and the fifth metatarsals are present. The former is easily identified by its large size and the latter by its proximal tuberosity. Both bones, as well as their phalanges, are normal. (Plate 3, fig. 3.)

Left foot.—The left foot presents three toes: the great, the fourth, and the fifth, each with a nail. The last two are syndactylized. The great toe is bent laterally and almost touches the fourth. The skin is like that of the other foot. (Plate 4, fig. 1.)

The tarsus is entirely similar to that of the right foot. Only the second metatarsal is absent. The third metatarsal is slenderer and has no phalanges. The first, fourth, and fifth, with their phalanges, are normal. (Plate 4, figs. 2, 3.)

CASE II

Our second case is a well-developed girl, aged 18, admitted to the Philippine General Hospital for some heart complaint.

Right hand.—Aside from a contracted condition of the middle finger and a diminutive supernumerary digit hanging by a narrow stalk from the base of the thumb, this hand is normal.

Right foot.—The right foot has only two toes, the first and the fifth, each provided with its nail, with their distal ends curved toward each other, as in the other case. There is also a deep cleft, extending to the metatarsal region, separating the two toes. (Plate 5, figs. 1, 2.)

The tarsus is apparently normal.

The second and third metatarsals are absent. The fourth is smaller and bent to the left. It has no phalanges. The first and fifth metatarsals, and their phalanges, are normal. Epiphyseal lines are distinct in some of the phalanges. (Plate 5, fig. 3.)

Left foot.—The left foot presents three toes, the great, the fourth, and the fifth, each with a nail and normal in appearance.

There is a Y-shaped cleft, extending to the metatarsal region, between the great and the fourth toes.

The tarsal bones are distinct except the cuneiform bones which do not show clearly in the picture. (Plate 5, figs. 1, 2.)

The metatarsals are all present. All are normal except the second and third; the second is smaller and curves to the right, and the third is slender and is longer due to fusion with the proximal phalanx which is rudimentary.

The phalanges of the first are normal; the second has no phalanges; the third has only the rudimentary proximal phalanx fused with its distal end; the fourth has a longer proximal phalanx and a shorter middle one, while the distal is normal. The phalanges of the last toe are normal except for the absence of the middle one; however, this may be fused with the distal phalanx, the base of which appears rather large. (Plate 6.)

DISCUSSION

In these two cases two interesting facts are prominent. First, that neither woman experienced any inconvenience in the performance of her daily duties; and second, that there is no history of such deformity in the other members of their families.

In this connection it is probably convenient to give a brief review of the embryological development of the skeletal parts of the two human extremities, especially as regards the metacarpals, metatarsals, and phalanges. According to Keibel and Mall and to Minot at about the third week of embryonic life the limb buds appear, formed by the condensation of the mesenchyme into scleroblastema. Between the fifth and sixth weeks, when the embryo has attained 11 millimeters in length, the hand and foot plates are differentiated; the digital rays appear as bars of scleroblastema, but they are not differentiated into metacarpals, metatarsals, and phalanges until the chondrogenous period. Later, chondrification centers appear, those of the metacarpals, metatarsals, and phalanges appearing before those of the carpals and tarsals. By the middle of the third month the cartilages of the hand and foot have acquired the adult shape. Ossification of the shafts of the metacarpals and metatarsals begins at the eighth or ninth week and that of the phalanges at the ninth or tenth week. The epiphyses of the metacarpals and metatarsals ossify from the third to the eighth year, and their union is accomplished at the eighteenth to the twentieth year. Epiphyseal ossification of the phalanges begins from the

fourth to the eighth year, and union to the shafts takes place at the nineteenth to the twenty-first year.

In our two cases we found no distinct epiphyseal lines except in some of the phalanges in Case II. This is in accord with the above embryological facts. The discrepancy in our cases from that of normal embryological development of bones lies mainly in the hypoplasia of some of the metacarpals, metatarsals, and phalanges, and in the total absence of some of the metatarsals and phalanges.

It can be deduced from the above considerations that any arrest of the bony development of digits in either extremity must have taken place before the eighth week of embryonic life.

The question of the etiology of these and similar deformities has been ably considered by several authors. The discussions mainly resolve themselves into four theories; namely, the theory of maternal impression, that of external influence, that of atavism, and that of heredity.

Maternal impression.—This theory may be considered only because of its historical value. It is closely linked with superstition, and entirely lacks scientific basis. This is at once apparent if we keep in mind that in most of the cases reported and explained under this theory the impression occurred after the normal period of ossification of these parts.

External influence.—Under this theory many authors include such influencing factors as mechanical agencies, pathological conditions in the ovum or its environment, etc. Of these, the mechanical theory is the most widely discussed. Malformations are explained by internal or external injuries to the embryo while in utero, resulting from such agencies as amniotic adhesions, cord defects, etc. It is probable that many cases of amniotic adhesions result from pressure upon or disease of the amnion. It is a conceivable fact that adhesions between the amnion and the embryo can mechanically prevent or pervert the growth of the parts affected; certainly there are on record cases of digital amputations resulting from adhesive entanglements with the amniotic bands. Moreover, pressure upon an extremity would indeed cause it to be stunted, and such pressure may result from a variety of causes, such as abdominal or uterine tumors, tight lacing, etc.

Cord defects may also be considered as causing amputation of digits, or other similar deformities of the extremities. Some cases of so-called spontaneous amputation have been attributed to them. We can imagine a few cases of ectrosyndactyly as

being produced by such factors, but we can hardly say as much of polydactylism.

It cannot be denied that some cases of digital deformity may be explained by the above considerations; but, on the other hand, it would be difficult to account in the same manner for malformation of the extremities observed in amphibia, known to be devoid of amnion, or for those deformities which often occur symmetrically in the two or the four extremities, unless we could conceive of a pressure resulting from some physiological condition.

Furthermore, the occurrence of such defects in families would, even though discontinuous, argue for some hereditary influence working independently of mechanical agencies.

Again, the deformity might also result from anomalous conditions within the ovum itself or in its environmental surroundings, such as deficiency in the germ cell or injury to it resulting from pathological conditions in the uterus at the time when its organs are undergoing development and differentiation. But here again, while we might concede the production of monstrous forms from such causes, we can hardly believe that such general conditions would result in injury localized only in the extremities.

It might be possible to explain these local malformations by defects in local nutrition; as, for instance, syndactyly due to deficiency, and polydactyly resulting from excessive nutrition of the parts. But how are we to explain the incidence in families?

Atavism.—Both polydactyly and ectrosyndactyly have been explained by some writers under the theory of atavism. The intimate association of these two deformities and their extreme difference do not commend dual explanation.

When the theory is applied to syndactyly some writers have in mind the Quadrumana. However, we found no writer who gives a definite statement on the subject or adduces any proof for it. Fotherby considered "the apposition of the great toe to the remaining representatives of digits and the dexterity with which they could be used as a near approach to the Quadrumana." It is the experience of all observers that the deformed never experiences any inconvenience in the performance of his daily tasks; but it does not follow that such dexterity is atavistic.

The argument put forth by some writers against atavism, that they have never seen normal parents give birth to deformed offspring, is answered by Hasselwander's family of brachy- and hypodactyly, and by Wilson's families of polydactyly, where such

cases had occurred. But the deformity of the grandparent was never identical to that of the grandchild, which fact again speaks against the theory of atavism.

Finally, the theory falls short if we remember that in these deformities there is great variation in details; no two deformed extremities in the same individual or in any two individuals are found exactly identical, and certainly we agree with Gegenbaur, that it is inconceivable that one extremity has one atavus while the other has another.

Heredity.—Heredity is, in our opinion, a more plausible theory than any of those given above. It explains not only most of the conditions, such as marked tendency to symmetry and quadruplicity, found in these and allied deformities, but also the occurrence in families through several generations.

The occurrence of these deformities in reported single cases, like ours for instance, is not sufficient to overthrow the theory; for in such cases the deformities might have been screened by the families, or these single cases might have been the first to occur in a family some of the descendants of which would be deformed.

The following table shows the strong hereditary tendency of this deformity as well as its allied deformities, brachydactyly and polydactyly. The numbers given in the columns under the different authors mentioned in the title indicate the deformed members in each generation in several families of these family trees, discussed by the authors. It does not include normal families in the same family trees.

The scheme of the transmission of deformity, however, is hard to define. It may be that the deformity determinants are transmitted through the gametes; but, are all gametes carriers of these determinants? Apparently this was not so in the twins of Mayer's family, one of which was deformed while the other was normal; nor in the families of Wilson and of Hasselwander where the deformity escaped one generation in some cases. But this discontinuity may still be explained by conceiving the deformity as made latent in one or two generations by the intervention of other characteristics.

It is, nevertheless, inconceivable that these determinants are invariably transmitted in some fixed form, for it has been shown that no two extremities or individuals had exactly identical deformities; and, as Lewis and Embleton say—

> It seems far more probable that a fundamental factor, which influences the ultimate general confirmation of the affected parts thru their normal representatives, is at fault, that it is transmitted, and that its interaction

TABLE 1.—*Showing hereditary deformities of the extremities.*[a]

Generation.	Ectrosyndactyly. (Split foot and hand.)				Brachydactyly.				Polydactyly.					
	Lewis and Embleton.	Fotherby.	Mayer.	Pearson.	Webb.	Wilkie.	Kidd.[b]	Hasselwander.	Windle (Farge.)	Wilson.				
										Case I.	Case II.	Case III.	Case IV.	Case V.
First	....	1	1	....	1	?	1	1	1	1	1	1	....	1
Second	1	1	6	4	1	2	2	3	1	1	?	5	2	2
Third	11	2	5	11	1	7	1	2	2	3	1	3	....	1
Fourth	14	9	1	10	5	3	2	....	....	2	4	1	....	....
Fifth	17	4	....	....	6	....	....	....	....	2	....	....	....	....
Sixth	1	....	....	....	3	....	....	....	....	1	....	....	....	....
Seventh	....	....	....	....	3	....	....	....	....	....	....	....	....	....
Total deformed	44	17	13	25	20	12	6	6	4	10	6	10	2	4
Total normal	32	10	6	14	10	4	....	17	1	39	....	10	1	....

[a] This table includes several families in family trees; normal families are not included.

[b] Ancestors are deformed.

with these representatives varies slightly in quality and quantity in different individuals and generations and that the varying interaction is produced by the interference of factors which may or may not be transmitted, such as those which may be conceived to account for the partial latency.

This hypothesis explains not only the latency and the variation but also the quadruplicity and the symmetry of deformity.

CONCLUSIONS

From the study of our cases and our review of the literature we can endorse the following general conclusions:

1. In the vast majorty of cases the deformity is quadruple.
2. One foot is never malformed alone; the deformity is symmetrical, and similar with individual variations.
3. In the foot the first and fifth toes are the more constantly present. The fifth toe is always present, while the first is in some cases missing.
4. Crossed bones are never found in the feet.
5. The hands are never affected if the feet are not malformed; in a few cases both feet and one hand are deformed.
6. There is generally metacarpal or metatarsal hypoplasia when the phalanges are absent.
7. Ectrodactyly generally affects the second or third toe.
8. Ectrodactyly proceeds from the radial side, avoiding bones as it approaches the ulnar side. In some cases only the little finger is present.
9. Ectrodactyly is less commonly associated with polydactyly than with syndactyly.
10. Syndactyly is generally confined to the fourth and fifth digits of either hands or feet.

ACKNOWLEDGMENTS

For assistance in the preparation of this paper we are indebted to Dr. Otto Schöbl, of the Bureau of Science, and to the departments of medicine and of physical therapy of the Philippine General Hospital.

BIBLIOGRAPHY

ANDERSON, W. Brit. Med. Journ. (June, 1886) 1107.

BAILEY, F., and MILLER, A. Text-book of Embryology. New York, William Wood & Co. 3d ed. (1916) 611.

DOWD, C. N. Ann. Surg. 24 (1896) 211.

FIDDES, J. D. Anat. Anz. 14 (1912) 544.

FOTHERBY, H. A. Brit. Med. Journ. (May, 1886) 975.

HASSELWANDER, A. Zeitschr. f. Morphol. u. Anthropol. 6 (1903) 511.

HAYS, G. P. Journ. Morphol. No. 1 **30** (1917) 65.
KEIBEL and MALL. Manual of Human Embryology. Philadelphia and London, J. B. Lippincott Co. **1** (1910) 366.
KIDD, W. Journ. Anat. and Phys. **44** (1910) 64.
LEWIS, T., and EMBLETON, D. Biometrica **6** (1908–9) 26.
MALL, F. P. Journ. Morphol. **19** (1908) 3.
MINOT, C. S. Text-book of Embryology (1897) 458.
PEARSON, K. Biometrica **6** (1908–9) 69.
PYE. Lancet **2** (1889) 1119.
TUBBY, A. H. Lancet **1** (1894) 396.
WATT, J. C. Am. Journ. Anat. **22** (1917) 385.
WEBB, T. L. Journ. Anat. and Phys. **35** (1901) 487.
WILKIE, J. Journ. Anat. and Phys. **24** (1890) 167.
WILSON, J. Journ. Anat. and Phys. **30** (1896) 437.
WINDLE, B. C. A. Journ. Anat. and Phys. **26** (1892) 100.

ILLUSTRATIONS

Fig. 1.

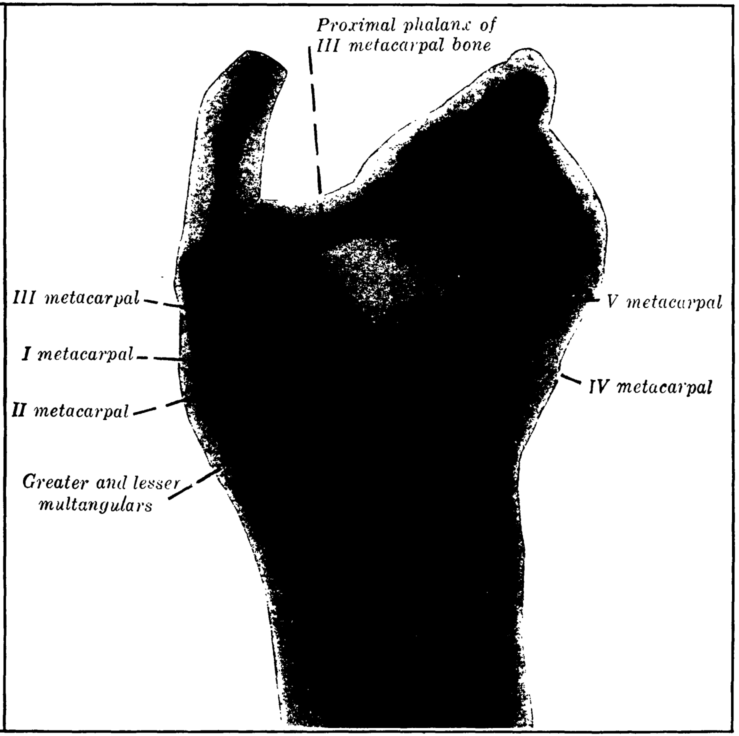


Fig. 2.

PLATE 1. CASE I, RIGHT HAND.

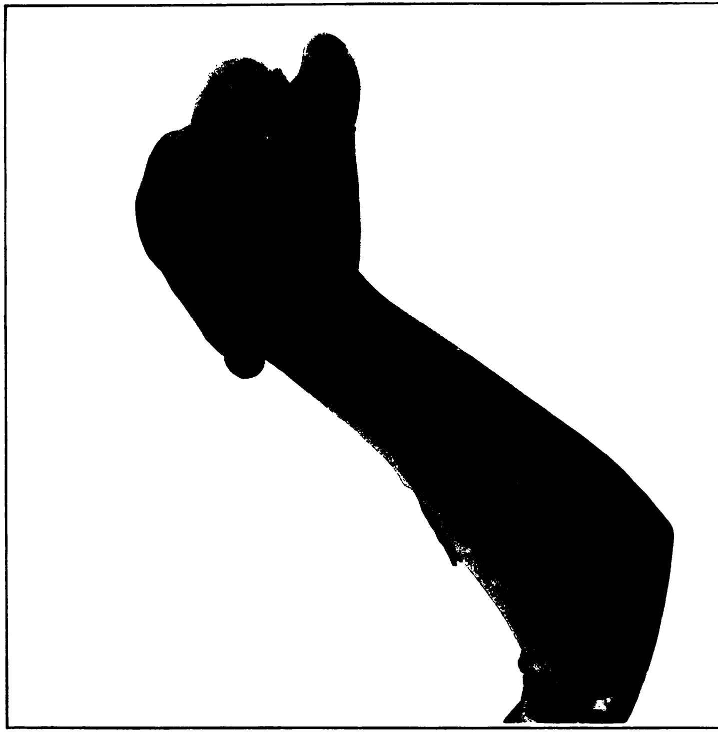


Fig. 1.

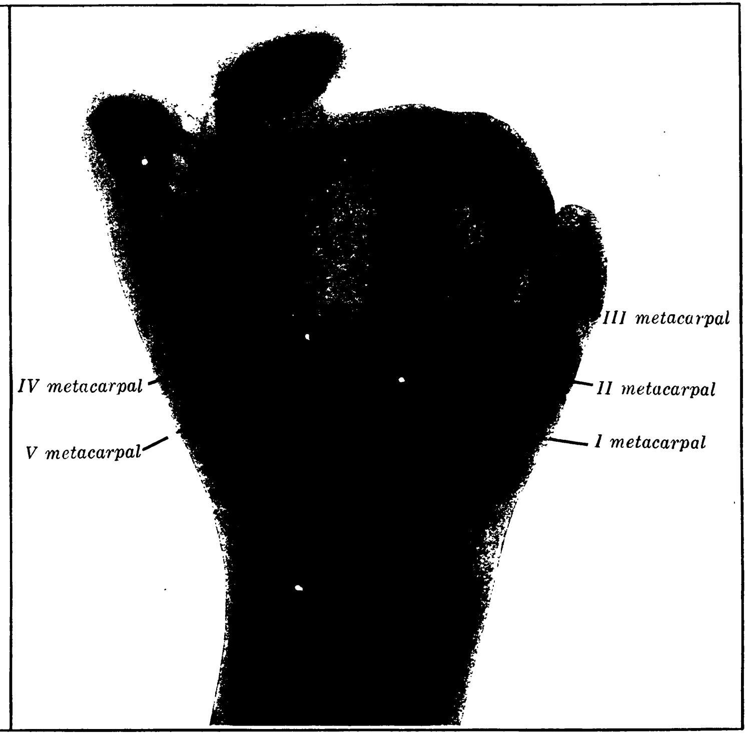


Fig. 2.

PLATE 2. CASE I, LEFT HAND.

Fig. 1.

Fig. 2.

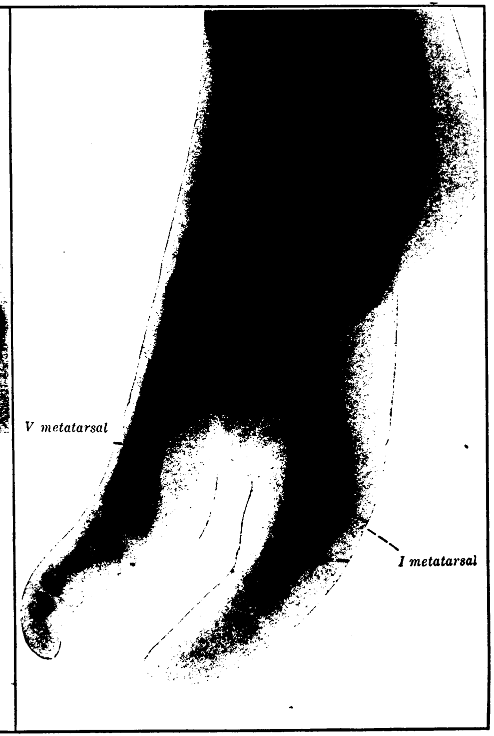


Fig. 3.

PLATE 3, CASE I, RIGHT FOOT.

Fig. 1. Fig. 2. Fig. 3.

PLATE 4, CASE I, LEFT FOOT.

Fig. 1.

Fig. 2.

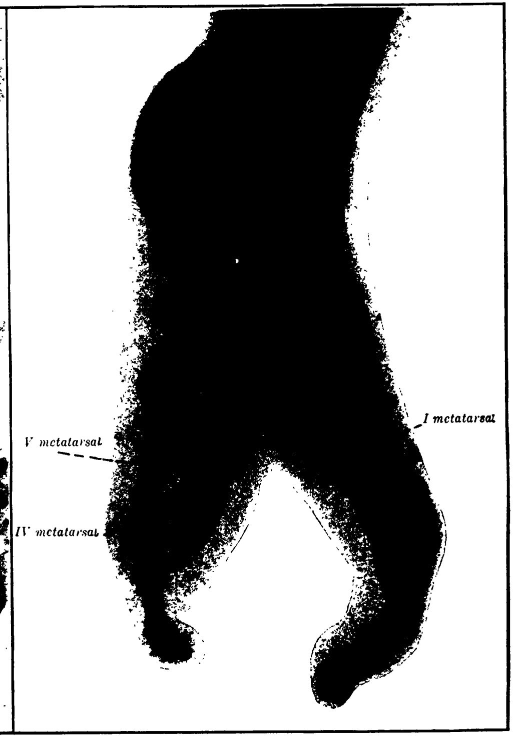


Fig. 3.

PLATE 5, CASE II.

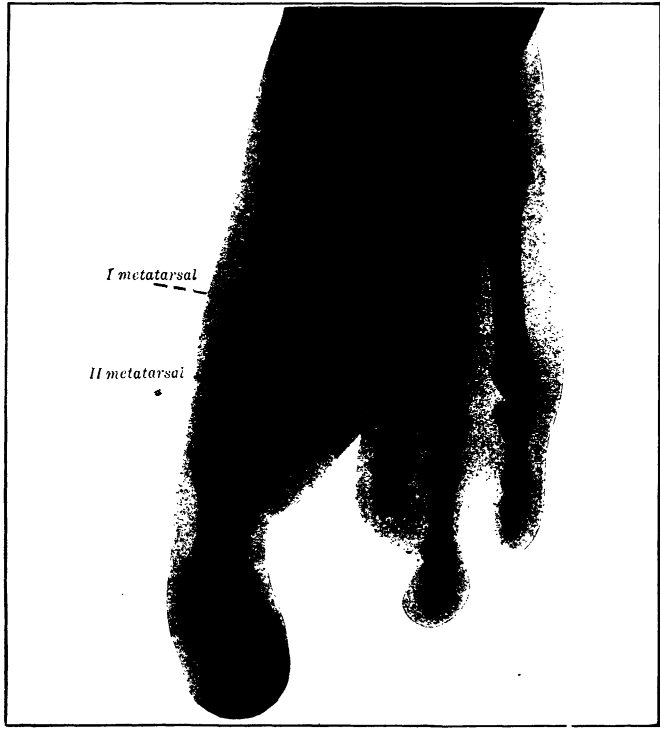


Fig. 1.

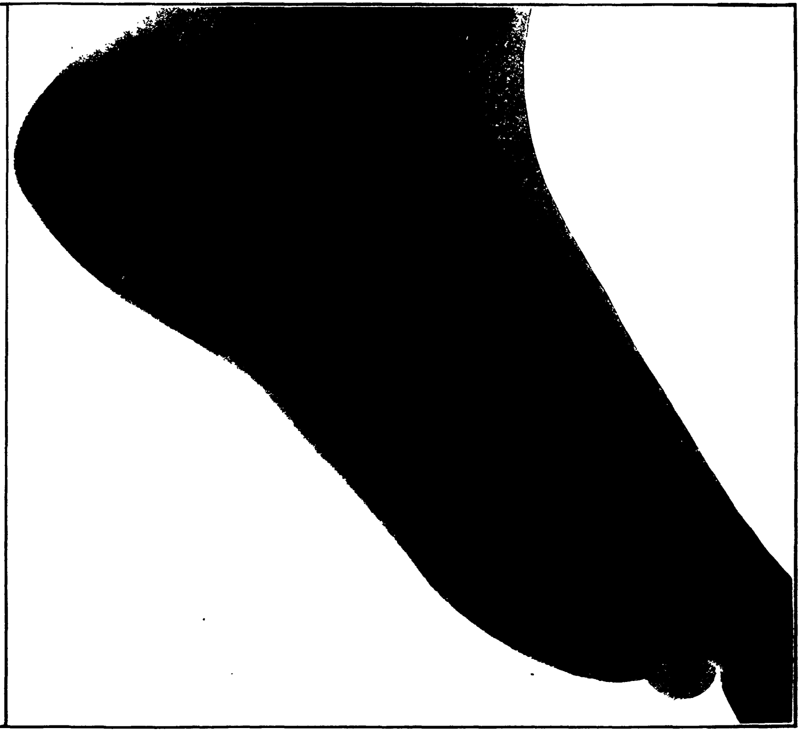


Fig. 2.

PLATE 6, CASE II, LEFT FOOT.

COMMERCIAL ACETYLSALICYLIC ACID [1]

By MARIANO V. DEL ROSARIO and PATROCINIO VALENZUELA

Of the Laboratory of Pharmaceutical Chemistry, School of Pharmacy, University of the Philippines

During the years prior to the World War there were only two factories in Germany which supplied acetylsalicylic acid to the whole world; the Farben-fabriken vorm. F. Bayer, of Leverkusen, whose product was known as aspirin, and the factory of E. Merk, of Darmstadt, where the constitutional chemical name was given to the preparation by the firm and its foreign agencies. Several English patents were issued, which one after another became invalid or void or were protested. A German patent, No. 93110 (June 14, 1896), "Verfahren zür Darstellung von Salicyl-essig-Säure," was granted to Dr. Ludwig Simpach, of Berlin.

When the World War broke out one of the sequels was the deliberate disregard of treaties and patents which ipso facto became "scraps of paper" and, as a consequence, this substance was manufactured in other countries of Europe as well as in North America and Japan. Though the name of aspirin was in most cases preserved, in France the substance prepared in the factories along the Rhone was called Rhodine. The name aspirin is now public property.[2]

The result of such extensive production of aspirin was the manufacture of a large number of preparations under this name or its synonyms, which were placed on the market, though perhaps they do not conform to the requirements of the different pharmacopœias.

[1] Read at the Philippine Pharmaceutical Convention on January 31, 1921.

[2] Extra Pharmacopœa, by Martindale and Westcott, London.

Note.—The Druggists' Circular 56 (June, 1921) 229 reports that in New York a case was tried before the court, the litigants being the Bayer Company against the United Drug Company. The judge decided that the word "Aspirin" is a trade-mark for manufacturing chemists, retail druggists, and physicians, but not a trade-mark for the public. Accordingly he ruled (April 14, 1921) that packages of 50 or less tablets can be sold to the consumer as aspirin; but packages containing more than 50 tablets (presumably for use by druggists and physicians) of the defendant manufacturer of Acetyl-salicylic acid may not be sold as "Aspirin."

Reviewing the pharmacopœias of several countries we find that the Swiss and Japanese of 1907; the French Codex and Swedish Pharmacopœia of 1908; the Italian and Hungarian of 1909; the German Pharmacopœia of 1910 (its prior edition being in 1900); the Norwegian of 1913, the British Pharmacopœia of 1914, and the Belgian Pharmacopœia in a supplement later than 1906, recognize acetylsalicylic acid as official, and all of them establish its characteristic properties as well as the tests for purity. It is, indeed, striking that the United States Pharmacopœia of 1910 does not list this drug among the official remedies; nor does it appear in the National Formulary. Undoubtedly the new edition of the United States Pharmacopœia will include this drug as an official one.

In examining different specimens of aspirin we are unable to determine a fixed, invariable criterion.

The solubility of acetylsalicylic acid is expressed in almost identical terms in the several pharmacopœias we have at hand. The melting point is fixed at 135° C., more or less, according to the experience of several authors as well as ourselves. The chemical reaction of aspirin should be neutral, but a slight acidity is admissible. The odor is supposed to be negative; the Pharmacopœia Helvetica, however, tolerates a light, vinegarlike odor. Aspirin in hydro-alcoholic solution must show no change toward ferric chloride solution, but the Pharmacopœia of Japan allows a weak violet coloration.

In the study of aspirin it is necessary to consider two kinds of reaction; namely, reactions leading to identification, and those showing its purity. It is clear that the constants and the different tests given in several pharmacopœias are sufficient for recognition or identification of this substance.

The test by the reagent of Tsakalotos, which is nothing but a modification of that of Mendelin,[3] is not conclusive for aspirin, since salicylic acid, salol, and similar compounds show the same result and, at most, it serves only to determine the presence of the salicylic acid radical. The same can be said in regard to the reagent of Kobert.[4]

However, the pharmacist is not primarily interested in the identification of a drug since, generally, this is guaranteed by the wholesale dealer. The purity of a drug is the important feature in which a professional pharmacist is interested. Unfortunately we have no official standards for the purity of aspirin

[3] Bull. Sc. Pharm. 25 (1918) 75.

[4] Loc. cit.

since the United States Pharmacopœia has, so far, set no standards.

With these conditions in mind we worked on the samples we secured from pharmacists and druggists in Manila and here give only our findings, without having formulated definite conclusions.

Table 1 shows the physical characters and constants of eight samples; two imported from Germany, two the product of German factories in America, and four of purely American manufacture.

TABLE 1.—*Physical constants of aspirin.*

Sample.	Appearance.	Color.	Odor.	Melting point.	Ash.
I	Silky needles	Pinkish white	Aromatic vinegarlike	131.5	0.00
II	Crystalline powder	do	Odorless	136	0.00
III	Silky prisms	White	Aromatic	136	0.00
IV	Crystalline powder	do	Vinegarlike	133	0.00
V	Fine needles	do	Aromatic	127	0.040
VI	do	do	Vinegarlike	131	0.059
VII	Crystalline powder	do	Aromatic	131	0.00
VIII	Fine needles	do	do	133	0.00

Discussing the physical constants shown in Table 1, we notice that the melting point of 135° C. given by the Pharmacopœia Germanica does not coincide with the results obtained from the samples examined by us—even with those from Germany. The British Pharmacopœia, however, accepts 133° C.

M. Auerbach, working on samples from three German factories for the Court of Arbitration of the Wholesale Druggists' Association of Hamburg,[5] fixed the melting point at from 132° to 134° C.

An interesting point in this connection is brought out by G. Capelli, of the Chemical Laboratory of the Italian Inspectorate of Military Hygiene. Capelli advances the idea that the melting point of aspirin varies with the solvent used in its crystallization. His results, and those of Hans Meyer, are as follows:

Solvent.	Capelli. °C.	Meyer. °C.
Water	126–129	....
Chloroform	134.2	....
Benzol	134.5	132.7
Carbon tetrachloride	134.5	133.7
Acetone and water	....	128.2
Alcohol and water	....	129.3

[5] Chemist and Druggist 93 (1920) 1274.

The melting point of samples crystallized in water and aqueous solvents is undoubtedly lower than that of samples for whose crystallization other solvents were used.

Capelli concludes that a melting point of 135° C. is the best index by which to judge the purity of this compound; temperatures of 124° to 130° are not allowed by the pharmacopœias, for it is believed that water retained by the sample induces partial saponification.

In the samples examined we noted that only the odorless samples (that is to say, those free from any appreciable dissociation) possessed a high melting point, 136° C. The same melting point, moreover, was shown by samples having an aromatic odor which was not related to either acetic or salicylic acid.

The evaluation or the determination of the purity of a sample of aspirin involves two titrations in the presence of phenolphthalein, according to A. Astruc,[6] which will show, first, its acid value and, second, its saponification value, thus:

$$C_6H_4\Big\langle\begin{matrix}CO\cdot OH\\ O\cdot OC\cdot CH_3\end{matrix} + KOH \longrightarrow C_6H_4\Big\langle\begin{matrix}CO\cdot OK\\ O\cdot OC\cdot CH_3\end{matrix} + H_2O$$

and

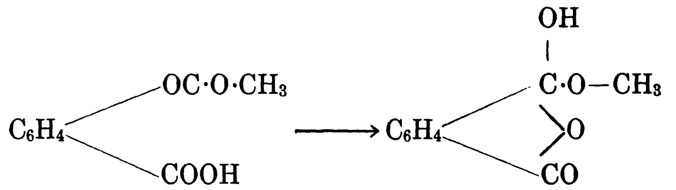
$$C_6H_4\Big\langle\begin{matrix}CO\cdot OK\\ O\cdot OC\cdot CH_3\end{matrix} + KOH \rightarrow C_6H_4\Big\langle\begin{matrix}CO\cdot OK\\ OH\end{matrix} + KO\cdot OC\cdot CH_3$$

These two evaluations complete each other because the first titration would be insufficient if used alone since, as Astruc says, if the acetylsalicylic acid were adulterated with a mixture of 76.66 per cent of salicylic acid and 33.33 per cent of neutralized salt, the result would be the same. Accordingly, in our work we determined the acid and saponification values or numbers and, by way of check, we also determined the bromine numbers to identify the salicylic radical in aspirin, which exists as such or under some other form.

Smith[7] assumes that acetylsalicylic acid, being so unstable a compound, may partially undergo molecular rearrangement in se, thus:

[6] Bull. Sc. Pharm. 25 (1918) 79.

[7] A. Nutter-Smith, Chemist and Druggist 93 (1920) 1038.



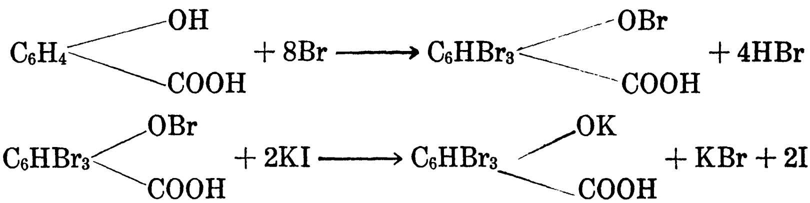
Moreover, in the examination of this wrongly named ester, which is rather a keto-acid, we determined the free acetic and free salicylic acid by methods which, if not accurate, at least give us the ratio among the samples examined.

The methods used by us were:

1. The titration of our group of samples dissolved in 15 cubic centimeters of alcohol rendered neutral with 0.2 *N* sodium hydroxide using phenolphthalein as an indicator.

2. To this neutral solution 50 cubic centimeters excess of 0.2 *N* sodium hydroxide is added, boiled under a reflux condenser for half an hour, and titrated back with 0.2 *N* sulphuric acid. The amount of sodium hydroxide used in both titrations for the acid and the saponification values ought to be the same.

3. The identification of salicylic acid by the bromine test is based upon the fact that four hydrogen atoms are replaced by bromine; of these four bromine atoms only one (that of the chain) and the excess of the solution react upon the potassium iodide solution, thus:



It is, therefore, evident that for each molecule of salicylic acid (molecular weight 138) three atoms of bromine ($3 \times 79.92 = 239.76$) are fixed. The number corresponding to sample 0 in Table 2 (which is theoretical) for the 0.2 *N* bromine solution is calculated for a one-gram sample.

4. As to free acetic acid, we used a method that gives only a relative content of the sample.

The method consists in washing a gram of the sample on a plain filter with small portions of distilled water at 15° C., up to a total of 25 cubic centimeters. The filtrate is then titrated with 0.2 *N* sodium hydroxide.

We have not used the aspiration method of Smith,[8] for it is very slow and we have not succeeded in getting good results by it.

5. The free salicylic acid was determined colorimetrically, applying a method based on the tests given by several pharmacopœias. These state that 0.1 gram of aspirin dissolved in 5 cubic centimeters of alcohol and 20 cubic centimeters of water must give no color with ferric chloride solution. The Pharmacopœia of Japan allows a light coloration in this test, which indicates that under local climatic conditions the best samples undergo partial dissociation.

A similar procedure was adopted in our experiment. Using solutions of salicylic acid of different concentrations and performing the test under identical conditions we compared the coloration in Nessler tubes.

In this way the results in the eighth column of Table 2 were obtained.

TABLE 2.—*Chemical constants of aspirin.*

Sample, 1 gram.	Acidic value.		Saturation value.		Bromine number.		Free acids.	
	0.2 *N* sodium hydroxide.	Corresponding salicylic acid.	0.2 *N* sodium hydroxide.	Corresponding acetic acid.	0.2 *N* bromine.	Corresponding salicylic acid.	Acetic.	Salicylic.
	cc.		*cc.*		*cc.*			
0	27.77	0.7666	27.77	0.3338	83.315	0.7666	0.000	0.000
I	28.12	0.7761	27.17	0.3261	72.90	0.6706	0.018	0.015
II	27.75	0.7659	26.96	0.3235	67.08	0.6171	0.016	0.007
III	27.92	0.7706	27.10	0.3252	65.19	0.6007	0.016	0.011
IV	27.57	0.7609	27.60	0.3312	75.00	0.6900	0.018	0.002
V	27.59	0.7615	28.26	0.3391	66.69	0.6135	0.019	0.008
VI	27.77	0.7666	26.26	0.3151	78.84	0.7251	0.011	0.005
VII	27.40	0.7562	28.13	0.3375	74.43	0.6847	0.026	0.011
VIII	28.77	0.7940	27.76	0.3331	79.23	0.7289	0.013	0.002

On analyzing the figures set forth in Table 2 it becomes apparent that certain samples, such as I and VIII, give a figure for acidity that is higher than the theoretical figures, and that Samples V and VII show the same peculiarity in respect of the saturation value. Impressed by these facts we checked the figures several times and found no reason to amend them.

We may say that in the table published by Jones we notice the same anomalies in several of his samples. As to the ex-

[8] Op. cit. 1037.

planation of this we venture the hypothesis, put forward by B. Baker,[9] that the more or less advanced hydrolysis and the amount of free acids are the reasons for such abnormality.

STANDARD QUALITIES

As a result of our experiments we hesitate to draw any conclusions, for we realize that the climatic conditions of our country are perhaps responsible for the deviation of the constants of the samples, even in those considered as the best.

As to the melting point, Jones [10] says that 136° C. is the temperature shown by samples of stable constitution, and any melting point lower than 135° C. (that required by several pharmacopœias) must not be accepted, for samples which have caused some trouble following administration to human beings have invariably showed the melting point to be below 133° C. In discussing the figures obtained by him in regard to acid and ester content the same author says: [10]

> The question now remains as to what analytical figures may be considered characteristic of the best grades on the market, and the following is suggested.
>
> Where the acid value is greater than the ester value, that the difference should not exceed 0.3 cc. N/5 soda [we suppose caustic soda] per gram and the bromine figure should not exceed the acid value by more than 0.15 cc. in similar terms. Where the ester exceeds the acid, the excess should not be more than 0.3 cc. soda per gram and in this case the bromine figure should not exceed the ester value.
>
> For free salicylic acid the limit should not be more than 0.15 per cent.

We cannot concur in this. Our experience shows that very few of the samples examined would come within these requirements. In our opinion the quality of the aspirin depends much upon the technic employed in its preparation. A well-washed sample is free from sulphate and chlorine ions. If it has been crystallized from a solvent other than water, and has then been thoroughly dried, its melting point will approach that of the pharmacopœias, and the liability to hydrolysis will have been minimized.

Nevertheless, all the requirements of purity which are valid in other countries should be modified after the drug has been subjected to our climatic conditions. All changes should be studied in situ, and the constants determined and required in

[9] Chemist and Druggist 91 (1919) 473. [10] Op. cit. 61.

other countries should not be indiscriminately applied here. In our opinion, if the United States Pharmacopœia is official in the Philippines, we should have an extra Pharmacopœia, something like the "Indian and Colonial addendum" that British India has for the British Pharmacopœia, wherein we might include not only our best-known indigenous remedies, but also the tolerable variations in the constants of imported drugs due to our climatic conditions.

GEOLOGIC RECONNAISSANCE OF THE PIDATAN OIL FIELD, COTABATO PROVINCE, MINDANAO

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TWO PLATES AND THREE TEXT FIGURES

CONTENTS

INTRODUCTION

During the latter part of February and the early part of March, 1921, the writer was engaged in a geologic reconnaissance in the vicinity of the Pidatan oil seep in the northern part of Cotabato Province, Mindanao, just south of the boundary between Lanao and Cotabato. He was detailed by the Governor-General to accompany the party of Mr. M. L. Benedum, a prominent oil operator of Pittsburgh, Pennsylvania. Mr. W. C. Spooner, chief geologist for the firm of Benedum and Treves, was also a member of the party, and the following report is a summary of the findings of the work done jointly by Mr. Spooner and the writer. However, the writer alone is responsible for the statements contained in this article.

On March 9 the Bureau of Science issued a press bulletin (No. 99) which was prepared by the writer, giving the general results of this expedition. As all details had to be eliminated from the bulletin it has been thought advisable to publish further, more-detailed information about this region for the ben-

efit of those who may wish to examine it in the future. It should be borne in mind that this is a very inaccessible region and very difficult to traverse, and that the time spent on the ground was just a week.

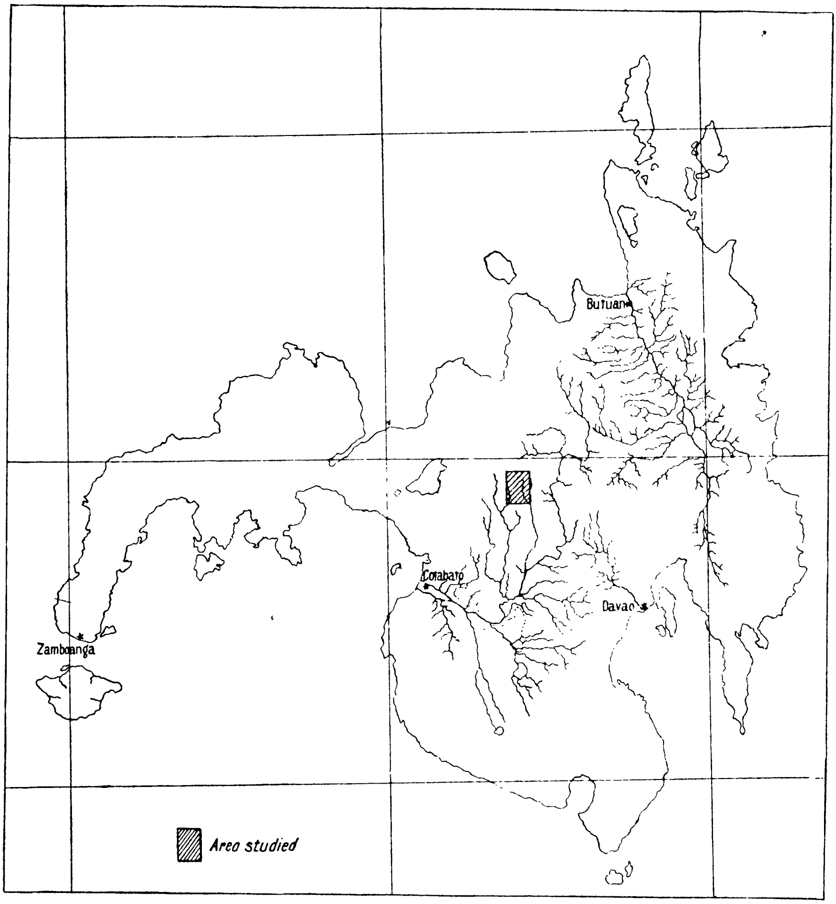


FIG. 1. Mindanao, showing the location of Pidatan oil seep.

GENERAL RESULTS

In the first place it should be stated that the results have been in the main negative; that is to say, the geological reconnaissance in the vicinity of the oil seep has revealed very unfavorable features, and the writer does not hesitate to condemn this locality as a prospective oil field. He is led to this conclusion by a consideration of the unfavorable geologic conditions as well as the difficulties of transportation, labor, supplies, etc. In view

of all these facts it is thought that any large expenditure of money or time in this locality would not be justified. There is undoubtedly oil in this field, but drilling here is not considered an economic undertaking.

On the other hand, the consensus of the geologists and the practical oil men of the party is that further intensive exploration in near-by regions of central Mindanao, either by the Government or by private capital, would be desirable. However, from the nature of the country and of the geological conditions, this work will require the services of many men for many months, at heavy expense. In order to get the geological facts about this region, it is necessary to use bolo-men constantly, and even with this aid the solving of the geological problems is very difficult and uncertain, owing to the scarcity of outcrops just where they are needed to complete the story. Without geological study practical oil men will not consider further expenditure. As the division of mines of the Bureau of Science is at present pitifully undermanned, there being one field geologist now (July, 1921) in the Government service, this work cannot be even considered by the Bureau of Science.

GEOGRAPHIC

Location.—The field investigated (fig. 1) is situated about 60 kilometers due north of Fort Pikit, Cotabato Province, Mindanao, which in turn is situated some 70 kilometers up the Rio Grande de Cotabato and therefore is very nearly in the heart of the great southern island. To the north of the field lies the volcanic range containing the active volcano of Mount Ragang, which in turn lies just back of Lake Lanao. To the west runs the line of hills and mountains known as the Babuy Mountains. To the east there are some moderately high hills and mountains of limestone, of which Mount Kitubud is the outstanding feature (Plate 1, fig. 2). The principal stream running through the field is the Malitabug which flows almost due south. This is a swift and almost unfordable tributary of the Rio Grande. The wild and picturesque gorge and the natural bridge of the Malitabug are special scenic features of the region. The old Government trail, now almost overgrown, which follows this stream is one of the finest in the Philippines, from a scenic point of view, and the natural bridge crossing the Malitabug is the most remarkable known in the Philippines.

Topography.—In general, the region under consideration may be called mountainous (Plate 1, fig. 1). The western part of

the field in the neighborhood of the Babuy Mountains is exceedingly rugged, with elevations up to 1,000 meters. The eastern part of the field is not so high, but owing to the limestone formation generally occurring in that portion the ground is exceedingly rough, and deep gorges are the rule. The center of the field is moderately level and open grassland in the vicinity of Malitabug River. Along Malitabug River are some very conspicuous terraces; three of these are prominently developed and two others are not so well defined. In the southern part of the field, just north of Fort Pikit, there is a great number of low hills, in part wooded and in part grass covered. Some of these hills are rounded and are made up of shales and sandstones, but many others are composed entirely of coral limestone and are generally flat topped. The hill on which Fort Pikit is located is typical of many of these hills (Plate 2, fig. 2). This is a raised coral reef of late Pleistocene or early Recent time. These outliers on the average stand about 50 meters above the Rio Grande. To the east of them lies the vast flat-bottomed valley of the Rio Grande.

After one has made a short study of this region, it is fairly easy to determine from a distance the general type of rocks underlying the different kinds of topography. For example, shale and sandstone are usually indicated by rolling, grass-covered hills; igneous rocks are found in the high, rugged, partially wooded mountains; the limestone areas are intermediate in elevation, usually with steep slopes and escarpments, and generally densely wooded. Traveling in the limestone areas is most difficult, owing to the considerable amount of solution-yielding caverns and sinks.

There is no accurate topographic map of this region available. An approximation to the topography indicated by hachures is found in the map issued by the Philippine Constabulary. The writer has seen a contour map of a portion of Cotabato Province, made some years ago by the topographers of the United States Army, but this map is not for general use. It is also known that private companies recently making investigations in this field have made topographic maps of a portion of this country; these also are not available to the public. The best way to map this country would be by photography from aëroplanes or by triangulation and plane-table sketching. The use of transit and steel tape is not necessary, as the preliminary geological work in this region does not call for such accuracy nor for

any great detail. This is a mistake that some geologists and engineers from the United States are prone to make.

Transportation.—Transportation to the Pidatan oil seep is first by launch from Cotabato to Fort Pikit, distant about 70 to 80 kilometers; thence by horses and cargadores over the Government trail, distant about 60 kilometers. The last 1.5 kilometers are exceedingly rough, and dangerous for horses, and should be made on foot. The trail (and this is practically the only trail worthy of the name in the region) as far as the forks, about 2 kilometers south of Banisilan, is a fairly good one. From this point to the seep the trail ascends gradually to an elevation of between 750 and 900 meters, and is exceedingly rough in places. The other branch of the trail continues to Banisilan, and is very good. The ford across Malitabug River below Banisilan is at times difficult to make, and during the rainy season practically impossible.

The country is very sparsely inhabited, hence the absence of good trails; such trails as exist are almost concealed and overgrown by the high grass (cogon and tigbao) which runs riot. With the exception of Banisilan, where there are a Constabulary outpost and a Moro farm school, there is no settlement worthy of the name. However, at Bao, one day's ride north of Pikit, there is a fairly good Government rest house with a telephone to Pikit and Cotabato. A few Moros and Manobos live in scattered groups of houses throughout this region. One sees scarcely more than a half dozen families in one settlement. The country is exceedingly wild and difficult, but gives one the impression of being capable of great development, particularly along agricultural lines. There is one small herd of cattle in the region which belongs to a Government company. For all supplies, transportation, etc., persons going into this region are dependent upon the Constabulary and upon Mr. Manion, the superintendent of the Moro Farm School at Banisilan. All arrangements of this kind should be made through the commanding officer at Cotabato. The present commandant is Captain Gutierrez, an exceptionally obliging and efficient officer; Captain Feria, at Fort Pikit, is an able second to Captain Gutierrez. Accommodations for small parties are available at Fort Pikit. Of course, any visitors to this country will naturally wish to visit Datu Piang, at Dulauan. Datu Piang is the most influential Moro in the province. Deputy Governor Abad, of Cotabato, who lives at the Agricultural Colony, just below

Pikit, is both very able and willing to assist visitors to this region.

Valuable notes relating to costs of transportation and supplies, furnished by Captain Gutierrez, of the Philippine Constabulary, are printed in the appendix to this article.

Climate.—Cotabato Province is in that portion of the Archipelago having no sharply defined rainy and dry seasons. January and February are generally considered the best months for field work. This region is outside the typhoon area and, therefore, is scarcely ever subject to storms. As there is no meteorological station nearer than Cotabato, near the coast, the writer does not know the rainfall of this interior basin. At Cotabato the mean annual precipitation is given by the Philippine Weather Bureau as 2,272 millimeters. It is probable that it is somewhat below this figure in the central Cotabato Valley.

At Cotabato the mean annual minimum temperature is 19.7° C., the mean annual normal is 26.6° C., and the mean annual maximum is 33.8° C. The annual normal is slightly less than that of Manila.

Population.—The population of Cotabato Province is about 21,000 persons, consisting largely of Moros segregated in towns along the Rio Grande, with some Manobos scattered through the hill country. In the Pidatan district the population is very sparse.

The Moros are Mohammedans, while the Manobos are pagans. Judged by the standards prevailing in the Christian provinces, these people are extremely backward. They engage in very crude agriculture, fishing, and trading. In the Pidatan district the few Moros and Manobos present lead an exceedingly precarious existence and appear to be on the verge of extinction.

GEOLOGIC

General statement.—The geology of the region briefly stated is as follows: The principal formations, as indicated on an early map published by the division of mines of the Bureau of Science, consists of Tertiary sediments: limestones, sandstones, and shales. These are intruded on the edges of the field by igneous rocks, principally basalts and andesites. There is considerable agglomerate also in the region. Owing to these intrusions and also to more widespread regional earth movements, these sediments have been folded and faulted, as in other parts of the Archipelago; some of them, especially the lower series, including the Vigo shales (the petroliferous horizon of the Philippines),

very profoundly. In the region adjacent to the seep the formations which might be counted upon to contain oil are so badly disturbed that no regular structures could be made out, and as this is the crux of the whole matter in an oil field, a favorable impression of this locality cannot be entertained. This does not mean that oil does not exist there. It might even be there in fair quantity; but with other difficulties, already referred to and which must be considered, drilling for oil does not promise to be an economic venture. This is a feature which many would-be oil producers do not adequately consider. Both the location of the seep and the composition of the oil, which has none of the light fractions and very little residue either of paraffine or of asphalt, indicate very local and abnormal conditions.

Description of formations.—The tentative stratigraphy of the Pidatan field is shown in Table 1. Beginning at the bottom the oldest rocks seen by the writer are the Vigo shales, with which are intercalated thin-bedded, sandstone layers. No deep-seated igneous rocks were noted, and it is probable that erosion has not proceeded far enough to reach them. The Vigo shales in this region are very much like the same formation in other parts of the Philippines, particularly in Bondoc Peninsula. A typical specimen is buff-colored with dark variations, exceedingly fine-grained, but not showing many microscopic forms such as *Globigerina,* as in the case of the Bondoc or Leyte shales. The shales and sandstones in this series are thin-bedded, and the shales break with a conchoidal fracture. Very few fossils were found in them. Structurally this formation is badly disturbed. Dips of 15° to 45° are common, and several outcrops show the shales and sandstones standing on end; that is, dipping 90°.

Overlying the Vigo series and with a marked angular unconformity is the Malumbang formation consisting of three members, as follows: The uppermost is limestone, fairly hard and white, and contains fragments of coral; below this is a soft, marly facies, quite fossiliferous; the principal genera found in this marl are *Cardium, Arca,* and *Tellina.* Below this marl comes a coarse, yellowish sandstone which contains a few fossils including some fragments of reef corals, and from the presence of these reef corals the writer concludes that this sandstone belongs with the Malumbang rather than with the Canguinsa, which was not seen by him and may be missing. Detailed work here may cause him to change this opinion.

Above the Malumbang come two or three formations, the exact positions of which are somewhat uncertain, particularly that of

TABLE 1.—*Provisional stratigraphy of the Pidatan oil field, Cotabato Province, Mindanao.*

Period.	Formation.	Lithology.	Estimated thickness.	Remarks.
			meters.	
Recent	Malitabug	River terrace deposits	75	Five terraces.
Pleistocene	Pikit	Raised reefs	50	Species of modern reef corals.
Lower Pleistocene or Upper Pliocene.	Banisilan	Coarse sandstone and shales	200+	Fresh-water and estuarine deposits; contain fragments of cogon leaves and stems of reeds.
Unconformity				
Pliocene	Malumbang	Upper coral limestone	300+	Fossil corals, very similar to those above mentioned.
		Marl		Contains numerous casts of pelecypods.
		Sandstone		Contains isolated fragments of reef corals.
Unconformity				
	Babuy	Andesitic agglomerate and intrusions	(?)	A part of the andesite and basalt intrusions of this region.
Miocene	Vigo	Shales and sandstones	(?)	Badly disturbed in region of seep.

the one which we shall call the Banisilan formation. This consists of coarse sandstones and interbedded shales, which the writer considers to be in part of fresh-water origin, since they contain fragments of wood and impressions of grass and reeds. This formation lies nearly flat in the vicinity of Banisilan, with a slight dip, not over 2°, however, to the southwest. In Malitabug River (Plate 2, fig. 1) a few kilometers south of Banisilan, are almost flat-lying loose shales belonging to this formation, but differing in lithology from those of the type locality near Banisilan.

From collections made in other localities by Mr. Moody and determined by Dr. R. E. Dickerson it seems that this formation was deposited in an embayment of the sea where leaves and grass stems were occasionally washed in. A good fauna was obtained by Mr. Moody from near Matinao about which Doctor Dickerson has kindly furnished the following notes:

The following species were collected from the Banisilan formation by Graham B. Moody at his locality 424 which he described as being 1.6 kilometers east of Matinao, and 0.6 kilometer west of Malitabug River, Cotabato, Mindanao:

List of species from Moody's locality 424.

GASTEROPODA

Calliostoma sp.
Cancellaria oblonga Sowerby.
Capulus sp.
Cerithidea sp.
Conus sp., large.
Conus lividus Hwass.
Conus insculptus Kiener.
Cypraea erosa Linnæus.
Cypraea sp.
Distortio clathrata Lamarck.
Dolium sp.
Eulima sp.
Murex cf. *pliciferas* Sowerby.
Nassa crenulata Bruguiere.
Nassa.
Natica albumen Lamarck.
Natica mamilla Lamarck.
Natica spadicea Reeve.
Pustularia nucleus Linnæus.
Ranella subgranosa Beck.
Ranella sp.
Sigaretus eximius Reeve.
Triton clavator Lamarck.
Turris flavidula Lamarck var. *sonde* K. Martin.
Terebra.

PELECYPODA

Arca cf. *barbata* Linnæus.
Arca cornea Reeve.
Cardita antiquata Linnæus.
Cardita pica Reeve.
Chama sp.
Cardium unicolor Sowerby.
Chione sp.
Corbula sp.
Glycimeris angulatus Lamarck.
Leiconcha trimaculata (Deshayes).
Lima sp.
Lucina sp.
Macoma nobilis Hanley.
Ostrea sp., a.
Ostrea sp., b.
Pecten squamosa Gmelin.
Pecten sp.
Spondylus sp.

COELENTERATA, ETC.

Echinoid spine.
Flabellum cf. *australe* Moseley.
Balanophyllia.
Cycloseris sp.
Three other coralline forms.
Vermes sp.

All the forms specifically identified are Recent species. The two forms *Flabellum* cf. *australe* Moseley and *Balanophyllia* also occur in Moody's locality 314, Agusan Valley, Agusan Province, where they are associated with—

GASTEROPODA

Cassis sp.
Cyclonassa elegans Kiener.
Nassa globosa Quoy.
Nassa crenulata Lamarck.
Nassa canaliculata Lamarck.
Cerithium jonkeri K. Martin.
Turritella terebra Lamarck.
Turris carinata.

PELECYPODA

Arca ferruginea Reeve.
Paphia striata Chemnitz.
Flabellum cf. *australe* Moseley.
Balanophyllia.
Cycloseris sp.

The form *Flabellum* cf. *australe* Moseley is identical with the species listed by Warren D. Smith from near Aroroy, on the west side of Aroroy Bay, Masbate, Bureau of Science locality F907, where it has a similar association as indicated above. The *Balanophyllia* may be an extinct species and the writer regards the association of these forms with similar assemblages of Gastropoda and Pelecypoda as not merely adventitious but indicative of essential synchrony. In other words, the Banisilan formation is equivalent to the beds exposed at Aroroy and the nearly horizontal beds at Moody's locality 314 in Agusan Valley. The latter are probably equivalent to beds referred to the Pliocene by Martin. Martin[1] listed Mindanao fossils as follows:

1. Left bank of Agusan River at Tagasáp.

Latirus madiunensis Mart. P.
Murex microphyllus Lam. M; L.
Ranella raninoides Mart. M.
Ranella gyrina Linn. L.
Turritella terebra Lam. Q; L.

2. Agusan River between Pagasap and Libuton.

Turritella terebra Lam. Q; L.
Venus squamosa Lam. P; L.

3. Maasin on the Agusan.

Conus insculptus Kien. M.; L.
Turricula bataviana Mart. P.
Murex verbeeki Mart. P
Natica mamilla Lam. M; L.

4. Salac y Maputi River.

Murex verbeeki Mart. P.
Strombus isabella Lam. Q; L.
Natica mamilla Lam. M; L.
Arca granosa Linn. P; L.
Clementia papyracea Gral. M; P; L.
Corbula scaphoides Hinds. M; P; L.

[1] Martin, K., Concerning Tertiary Fossils in the Philippines, English translation, Twenty-first Annual Rep. U. S. Geol. Surv. pt. 3 (1901) 619, 622, 623.

5. Zamboanga, river bank 2.5 miles north of Zamboanga, upper stratum.
Murex capucinus Lam. L.

Concerning these species, he states his opinion on pages 622 and 623:

"As for Mindanao, it can not be demonstrated from specimens which have been investigated that Miocene strata occur there, for I have but a single species, *Ranella raninoides* Mart., which is known only in the Miocene. On the other hand, it is clear that there are upper Tertiary beds along the Agusan River. If it were permissible to assume that all the fossils of the list given above originated in equivalent beds, and their state of preservation makes this probable, there would be in all 10 species, 6 of them, or 60 per cent, still living; 4 species occur in the Miocene and the same number in the Pliocene; but of these last three are known only from the Pliocene. These are *Latirus madiunensis* Mart., *Turricula bataviana* Mart., and *Murex verbeeki* Mart. All this argues the occurrence of the Pliocene on the Agusan River, and in harmony with this indication is the exceedingly fresh appearance of the fossils at hand.

"The same age finally may be ascribed to the fossils from the river Salac y Maputi in Mindanao; for although of the 6 species determined from this locality no fewer than 5 belong to the present fauna, yet of these latter 4 reach back to the Miocene and Pliocene and a single species *Murex verbeeki* Mart., is known only in the Pliocene. Of the deposit at Zamboanga nothing definite can be said as yet on the strength of the solitary fossil *Murex capucinus* Lam.

"To the age determinations of Philippine fossils it is proper to add that their state of preservation resembles that of the Javanese fossils to a very remarkable extent—to such a degree, indeed, that the specimens from the two regions might easily be confounded. The same statement is true of the tuffs and marls in which they were embedded, and this accords with the fact that the younger massive rocks of the Philippines show an extraordinary likeness to those of the East Indian Archipelago."

The writer is in entire agreement with Martin's assignment of the Agusan beds to the Pliocene and their analogues, the Banisilan formation, as well. The descriptions of Moody and Smith of the stratigraphic relations of the tuffaceous sandstones at Banisilan yielding the above fauna to the conformably underlying coralline limestone indicate that the Banisilan is upper Pliocene since the coralline limestone is largely composed of corals characteristic of the Malumbang formation of Pliocene age.

Percentages given in Martin's statement above are calculated on a total of ten species from four different localities and the number of forms is too small to be truly significant. The *Turricula bataviana* Martin occurs at Bureau of Science locality F1054 near San Rafael, Agusan River, where it is associated with a fauna containing at least from 90 to 95 per cent Recent species. Without going into great detail, the writer's judgment concerning the age of this fauna is strongly influenced by a recent study made upon a fauna obtained from the Vigo group of Miocene age which contained an astonishingly large number of Recent forms. The conclusions given in this paper are that the evolution of Gastropoda and Pelecypoda in the Tropics is far slower than in the Temperate zones and hence a different percentage scale in the Tertiary

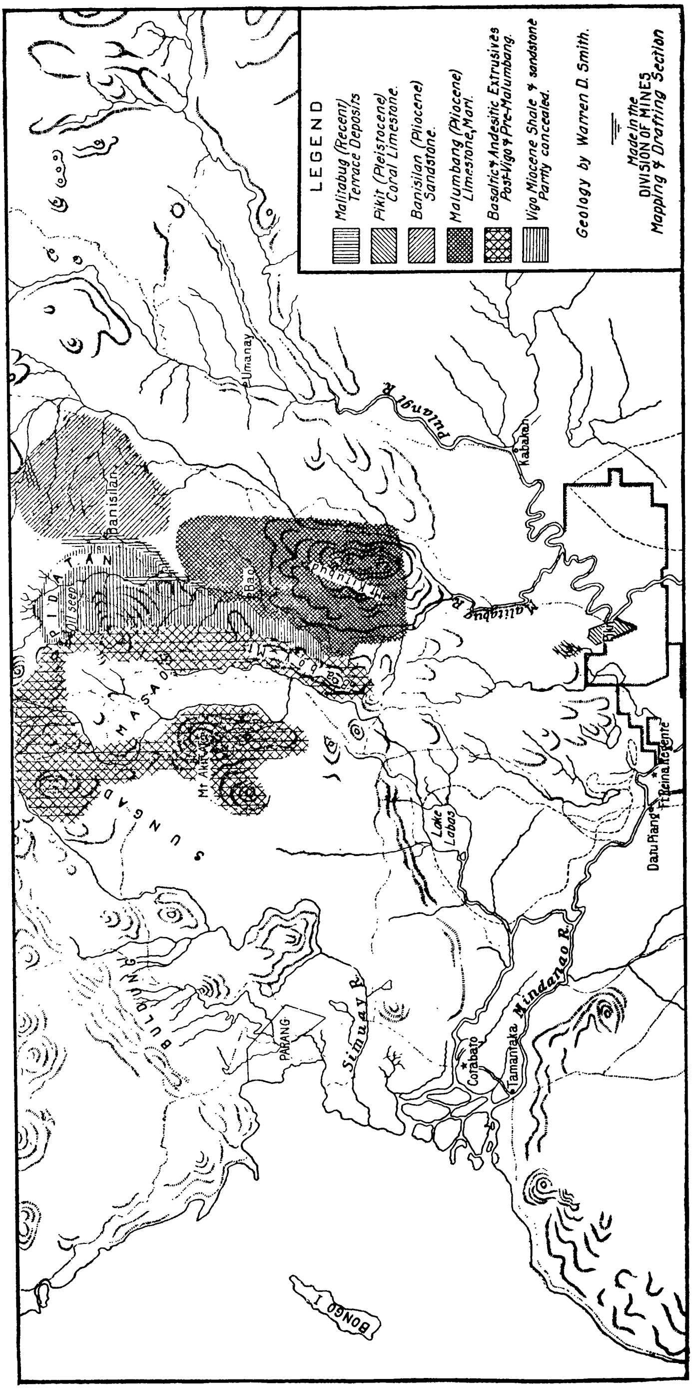
must be applied in evaluating the Miocene, Pliocene, and Pleistocene of the Torrid zone.

Above this formation stratigraphically, but not always topographically, are two formations which are probably contemporaneous. One, which comprises the terrace materials along Malitabug River, the writer called the Malitabug formation; to the other, comprising the elevated coral reefs so well developed in that locality, he gives the name of Pikit, These two, he considers, date from the late Pleistocene. The Banisilan formation he assigns to the early Pleistocene or late Pliocene.

In this region are several types of igneous formations. The Babuy Mountains are a great mass of andesite and basalt, and on the flanks of these mountains there is considerable andesitic agglomerate. These materials, the writer believes, are intrusive in the Vigo formation, but not in the Malumbang; that is, they are post-Vigo and pre-Malumbang. At the seep on the flanks of the Babuy Mountains the oil appears to be issuing along a fault plane on one side of a dike which runs out from the main mass in an east–west direction. The rock is so badly weathered and decomposed (it is also somewhat metamorphosed) that it has been difficult to make an accurate petrographic description of it. There seems to be no question that it is igneous. On the hanging wall there is a very much-broken mass of material which may be either agglomerate, locally brecciated igneous rock, or merely talus. Thin sections of this igneous rock showed considerable decomposition and crushing, giving to the section the appearance of a volcanic tuff. There are some large crystal fragments in the section, principally of feldspar. There is a suggestion of clastic texture, but the writer is of the opinion that this is secondary. Therefore, it is difficult to state positively just what this material is. It appears, however, to be a badly crushed andesite or basalt. In an unpublished report on this region the opinion is expressed that this seep is located along a fault plane in sandstone. Neither the field nor the laboratory examination of this rock, in the opinion of the writer, justifies this classification.

Owing to the lack of detailed work in the region, we can give only an approximation to the thickness of the various formations in this region, and such estimates as we can make are shown in Table 1.

The general distribution of some of these formations is shown on the sketch map, fig. 2. From the nature of the topography



Base taken from large map by the Philippine Constabulary.

FIG. 2. Sketch map, showing areal distribution of formations in the Pidatan district, Cotabato, Mindanao.

and their areal distribution it appears probable that Malitabug River is located along a fault line. In fig. 3 is shown a generalized cross-section suggesting the geological relationships in this region.

ECONOMIC

Description of seep.—The only indication of petroleum in this field is a single seep, and a very small one at that, which is located in a ravine on the headwaters of Kirusoy Creek, a tributary of Malitabug River. This is well up the side of a partially wooded range of igneous rock, and on the south side of what appears to be an east–west dike running from the main mass.

The amount of oil and gas issuing at this point is very small; compared with other seeps in the Philippines and elsewhere, it is not very encouraging. It is said that a 5-gallon can of this oil can be collected in a day from this seep. The writer doubts this. In Table 2 is presented the analysis of this oil made by chemists of the Bureau of Science and, in Table 3, an-

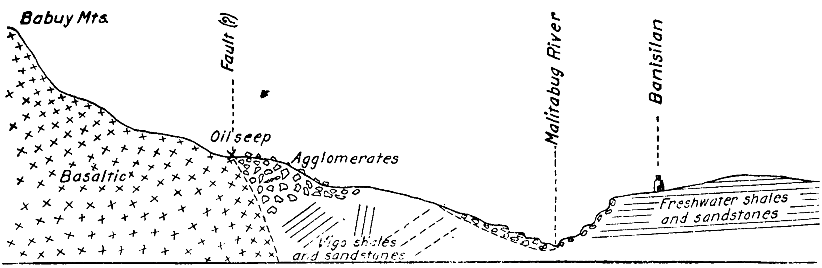


FIG. 3. Generalized cross-section east and west through Pidatan oil seep.

other analysis, by Mr. Winkler, chemist for the United States Army Quartermaster, Manila. Accompanying the analysis by Mr. Winkler, is a memorandum relative to the possible uses for this oil. It will be noticed that this oil has neither "head" nor "tail;" that is to say, the light fractions such as gasoline, benzene, and kerosene are absent, and it has only from 1 to 2 per cent of wax, or paraffin, residuum. This indicates that the oil is abnormal and has lost some of its constituents in migration. Therefore, it is presumed that either the oil has come from a considerable distance through the formations or it has suffered distillation locally, due either to the heat of cooling igneous rocks or to heat generated during metamorphism. In the parlance of the practical oil man this is a "wild" oil.

TABLE 2.—*Analysis of oil from Pidatan, Mindanao.*

[Analysis by the Bureau of Science.]

Specific gravity at 15.6° C.	0.9297
Distillation:	
Light oils (below 150° C.)	None.
Burning oils (150° to 300° C.)	45 per cent by volume.
Heavy oils (300° to 400° C.)	49.5 per cent by volume.
Residue	5.5 per cent.
Sediment	Large amount.
Water	Trace.
Base	Paraffin.
Main calories or gross heating value	12,495.
Available heating value	11,189.
Sulphur	1.56 per cent.

TABLE 3.—*Cotabato oil, from Mindanao, P. I.*

[Analysis by J. Winkler, chemist, Quartermaster Corps, United States Army.]

Gravity at 60° F.	20.5 Bé.
Specific gravity	0.928
Flash, open cup	233° F.
Moisture	Traces only.
Sediment	Traces only.
Fire, open cup	261° F.
Asphalt	0.00
Wax, approximate	1–2 per cent.
Gasoline	0.00
Benzine	0.00
Kerosene	0.00
Sulphur	Trace only.
Saponifiable, as resin oils	0.00
British thermal units	19.965 [a]

[a] Determined by the Bureau of Science.

Direct industrial uses:

(*a*) This oil as it stands is splendid Diesel engine fuel, and it is splendid oil for compressed air burners for furnaces. Or, it is splendid for mixing with the "to heavy" California crude petroleums for both purposes named above.

(*b*) It is an excellent oil for oil-burning ranges in hotels et al. where "soot less" odorless flame is required.

(*c*) It can be used as lubricant with constant "drip" . . . on bearing.

(*d*) Because so low in sulphur, it would be an excellent solvent in the rubber recovery.

Manufactured products from this oil:

(*a*) By simply blowing hot air through this oil, it becomes splendid transformer oil since so low in sulphur. Also a light household lubricant, as is "3 in 1" oil, etc.

(*b*) By steam distillation: Three products can be made; viz.:

(1) Heavy illuminating oil for bunker lamps, an oil of greater safety than kerosene. Also a cleaning oil. A floor oil.

(2) Lubricating oil for light machinery . . . some 40 per cent by volume.

(3) Heavier lubricating oil, by distilling off the light portion, and refining the residuum with sulphuric acid, washing with water, some 20 per cent by volume.

Samples of these products were made in the laboratory with amounts obtainable indicated, and these submitted with this report.

Exploitation.—Diligent search within a radius of several miles of the seep for favorable oil structures was made, but none was found. It is true, one little anticline, only a few meters in width, was seen in a section along the banks of Malitabug River, but this indicates merely a local roll and nothing of economic importance. In fact, the Vigo formation is so badly disturbed for some kilometers from this seep that it is extremely doubtful that a suitable structure could be found. The writer is informed that the present drilling sites in Borneo are about 50 kilometers from the discovery seeps. In general, it would be good policy to go some distance from this locality in a search for favorable structures. The writer does not hesitate to condemn all the country within a radius of 10 kilometers of this seep. However, he is of the opinion that further intensive geological exploration in the country to the east and south of this oil seep not only would be justified but would probably yield results. This subject is discussed further in a later paragraph.

It is not sufficient merely to find oil in the rocks; there must be oil in sufficient quantities and in an accessible location so that it can be marketed economically. As this is just where many oil-development projects fail the writer takes particular pains at this time to indicate some of the factors involved in the development of a region like this one.

In the first place, there must be the preliminary geological exploration, conducted in much greater detail than was the survey upon which this article is based. This will require the services of two or more geologists and assistants working steadily for at least six months, and possibly a year. This is the minimum, and it would be well to expect to spend at least 15,000 pesos in making such a survey.

Next will come the building of a road, in order to get machinery to the drill site. The writer has heard of estimates of 25,000 dollars (50,000 pesos) for the total cost of a road into this locality. Such estimates are absurd. It will cost in the neighborhood of a half million pesos, and very probably much more, to build a suitable road in this locality.

The drilling of one well to a depth of 1,000 meters, including the cost of machinery set up on the ground, will cost about 200,000 pesos.

A pipe line out of this field would require at least 2,000,000 pesos, and then a refinery, with tanks and with transportation facilities, will call for another 5,000,000 pesos, at the lowest. It can be easily seen that the expenditures for any real operations in this country will mount rapidly to the 10,000,000-peso figure.

Labor.—Practically all labor for operations on a large scale in this country will have to be brought in from the outside. The Moros and Manobos cannot, in the writer's opinion, be counted upon either in numbers or in quality of work. The bulk of the labor will have to come largely from the Visayan Islands or from still farther north. The average wage for common labor in this country is from 80 centavos to 1 peso per day. All skilled labor and equipment will have to be brought from the United States, and all supplies from Manila. In landing machinery and supplies in this field there will be heavy freight, insurance, and lighterage charges.

Hints to explorers.—Elsewhere [2] the writer will publish some instructions to exploring parties who intend to visit this region. Therefore for editorial reasons they are not incorporated in this article. A general word of advice is inserted here; namely, before leaving the United States or other foreign country such persons should write either to the Bureau of Insular Affairs in Washington, or direct to the Philippine Bureau of Science in Manila for full directions. Unless one has had previous experience in the Islands he should not for a moment presume to guess about these matters, because guesswork would result in inconveniences and might prove to be fatal.

For the guidance of persons going into this region a few figures relating to costs and transportation, furnished by Captain Gutierrez, senior inspector of Constabulary of Cotabato Province, are given in the appendix.

Geological exploration.—As preliminary work in this region, the writer would suggest that a detailed section be made of Malitabug River to the Lanao boundary, another from Malitabug River due east through Banisilan to Pulangui (Rio Grande or Cotabato) River, and a third from Malitabug River due west to Parang. After this work, which will require at least three

[2] Manual for Scientific Travellers, Delft. (In preparation.)

months, has been completed the work to follow will naturally suggest itself. A general reconnaissance should be made first; detailed mapping should not be attempted in the beginning. It is not necessary to go to the elaborate precautions of keeping extra barometers in camp in order to check the one used in the field; the dip or strike of an outcrop recorded with an accuracy of a degree will be close enough. Some geologists doing reconnaissance work in the Philippines make the mistake of attempting too much detail, and they waste time in trying to be precise. It is not necessary in route surveying to set up the instrument over a tack when an error of several feet could not be shown on the scale of the map.

CONCLUSION

While the geological conditions in the vicinity of the Pidatan oil seep are unfavorable and not much encouragement can be given for development in that particular locality, the writer is of the opinion that in near-by regions of central Mindanao, in the areas covered by sedimentary rocks, there is the possibility of locating oil structures; this can be determined by future geological exploration. At this point the writer would caution those who are not initiated into the intricacies of the oil business that such geological exploration is absolutely essential. The large, successful concerns in the oil business to-day would not think of proceeding without such work. Yet, once in a while, one hears the man in the street say that he does not care for that sort of thing and that he wants a "practical" man. The writer is as appreciative as anyone else of the practical man in his field, but the work of the geologist is just as practical as that of the driller. It is simply a different kind of work, for which a very different sort of training is necessary, and because the layman does not understand the nature of the work he has no justification for calling it impractical. Often the so-called "practical" man is the most impractical. Men who are well versed in this business know that both the geologist and the experienced driller are necessary to get the oil. Both are apt to make mistakes, but when they work together they reduce the chances for error.

APPENDIX

Launches.—The Provincial Government launch *Ripley,* at 6 pesos per hour, can reach Gocotan on the Maridagao, a tributary of the Rio Grande (Cotabato now), and also Kabacan at the junction of Cotabato and Kabacan Rivers, which are both above

Pikit. From Cotabato this launch takes from thirteen to fourteen hours to reach Pikit; from fifteen to sixteen hours to reach Gocotan; and from nineteen to twenty hours to reach Kabacan. The engineer's launch *Raja,* at 5 pesos per hour, can reach the same points as the *Ripley,* but it is a slower boat. These two launches are always available when not actually in use by provincial authorities.

In addition, the Constabulary, Bureau of Lands, Bureau of Education, and Bureau of Health launches can be made available at an average cost of from 5 to 6 pesos an hour, if officially requested. The Constabulary launch's limit of navigation is Fort Pikit.

The launch *J. H. Hall,* run also by the province, is a good-sized stern-wheel river boat, which ordinarily carries between 100 and 200 tons of cargo. It easily reaches Pikit from Cotabato, but Gocotan and Kabacan with difficulty and at certain times of the year only. The charge per hour for hire of this launch is 10 pesos. It ordinarily takes about twenty-four hours to reach Pikit from Cotabato, after a few hours' stop at different points.

Vintas.—Vintas are obtainable from most points along the river where there are Moro settlements, through Government authorities or Moro datus. If time is given in advance twenty or more vintas can be obtained. The hire of small vintas alone is from 50 centavos to 1 peso per day, but for the larger size from 1 to 2 pesos. Each vinta should have at least three or four men to run it, for each of whom subsistence at from 70 centavos to 1 peso per day must be paid. The charge for subsistence differs with the locality and the circumstances. Vintas can reach a point near Malitabug camp on Malitabug River with no little difficulty, and can easily reach Kabacan, Gocotan, Pikit, and Dulawan. The vintas travel from 1 to 2 miles an hour against the current when it is not too strong.

Horses.—Ponies are obtainable at Cotabato, Dulawan, Pagalungan, Pikit, and Kidapawan; from 4 to 10 ponies can be hired in each place, if sufficient time is given in advance. It is advisable to get them through the Government authorities or datus. The hire of each horse is 1 peso per day, from the time the horse or pony leaves the owner until it is returned to him. Saddles and bridles should be furnished by the person hiring the horses, as the Moros use either none or poor equipment of this nature.

Cargadores.—Cargadores are obtained principally at Cotabato, Dulawan, Pikit, and Pagalungan at from 70 centavos to

1 peso each per day, depending on the exigencies and the need of their services, in addition to subsistence. Sufficient time in advance should be given to the officials or datus whose aid and favor are asked.

Supplies for cargadores.—Two and a half to 3 chupas of rice per day for each cargador is the rule in this country. There are 8 chupas of rice to 1 ganta. One ganta equals 3 liters, dry measure. A chupa of rice costs from 7 to 10 centavos. Cargadores also subsist on dried fish, salmon, and sometimes chickens and salt. All of these can usually be obtained at Cotabato. Chickens can be obtained in the Moro settlements throughout the country. Dried salted fish at present (May, 1921) costs 90 centavos per kilogram; a case of 48 cans of salmon, 13.44 pesos; salt, 1.70 per sack; chickens, 30 to 50 centavos. The average cost of subsistence per day per cargador is from 30 to 40 centavos.

Supplies for Americans.—American subsistence will cost from 3 to 4 pesos on the average. Cream crackers, rice, and some canned supplies can be obtained at times at Pikit, but stores and market there cannot be depended upon. Chickens and eggs can be obtained at Dulawan and Pikit, if sufficient time in advance is given for procuring them. Chickens cost 30 to 50 centavos each and eggs from 2 to 4 centavos each, depending on the time. Supplies, other than chickens and eggs, which might be obtained at Pikit will cost at least 5 to 10 per cent higher than if purchased in Zamboanga or Cotabato. Canned goods and potatoes should be brought from Manila, Zamboanga, or Cotabato. Supplies are scarce after leaving Cotabato.

Additional information.—The present cost of transporting supplies from Manila to Cotabato is 16.75 pesos per ton. The information given above holds good principally along Cotabato River. The supplies and cargadores are hard to get in these regions. People going into such regions should have a sufficient number of cargadores and extra rations. Travelers should carry plenty of change for paying cargadores when discharged; discharged cargadores should be given sufficient food to last them till their arrival at their homes. People carrying large sums of money should be very careful not to allow outsiders to know it. It is advisable in all cases for travelers to see the Constabulary station commander at Pikit before leaving that point for the interior to ascertain whether it is necessary to have an escort.

ILLUSTRATIONS

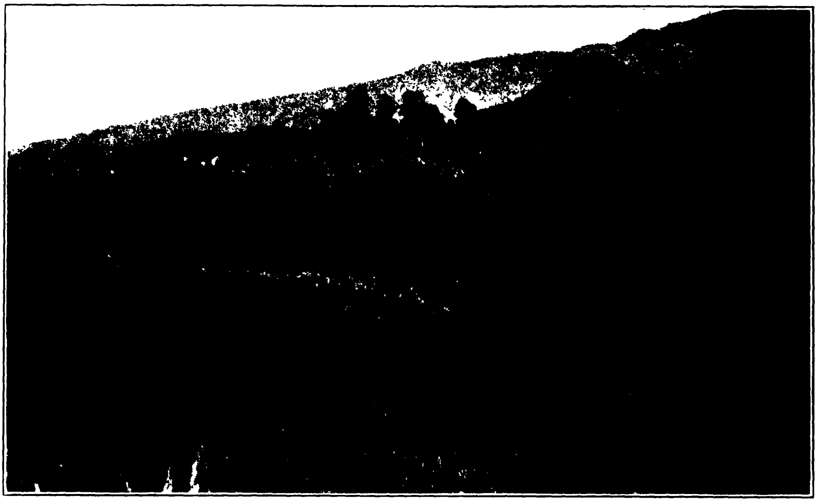


Fig. 1. Topography in the vicinity of Pidatan oil seep.

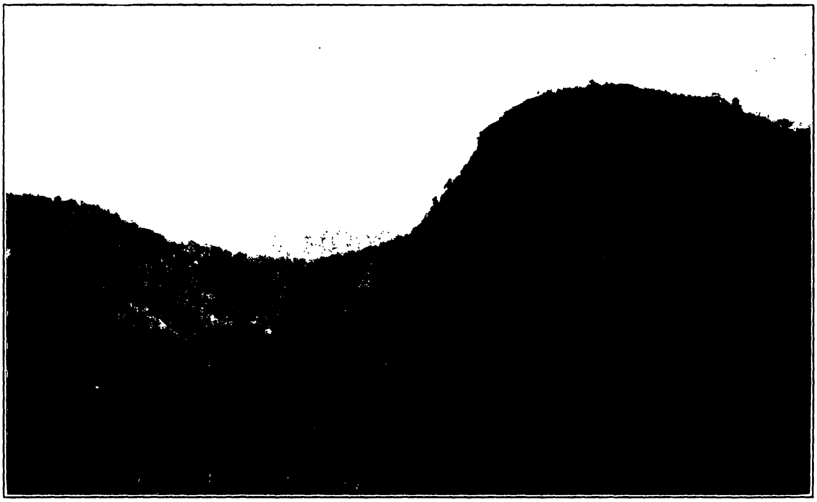


Fig. 2. Mount Kitubud (Pliocene limestone) and valley of the Malitabug.

PLATE 1.

Fig. 1. Pliocene shales on Malitabug River.

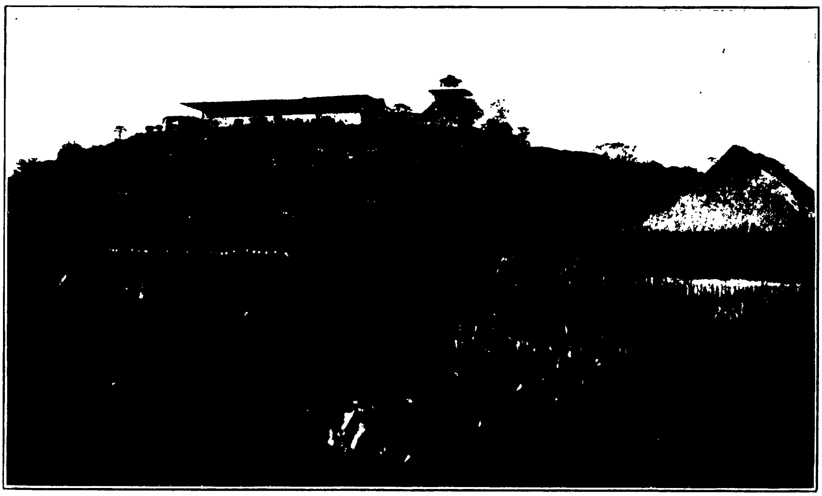


Fig. 2. Fort Pikit on Pleistocene coral outlier in Cotabato Plain.

PLATE 2.

RECENT IMPROVEMENTS IN NIPA-SUGAR MANUFACTURE

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and
G. A. PERKINS
Chemist, Bureau of Science, Manila

THREE PLATES

Interest in the problem of palm-sugar manufacture naturally changes from year to year according to the variation in the price of sugar. At present writing the dull market effectually removes any possibility of large investments in the nipa-sugar industry. Nevertheless, in certain portions of the Islands, where nipa is abundant, and pesos to buy cane sugar are scarce, nipa sap continues to be used to a limited extent for the production of sirup for local consumption, and the possibility of manufacturing crystallized sugar remains an interesting one.

Since the work of Gibbs,[1] Pratt, and others,[2] no extensive nipa-sugar experiments have been undertaken by the Bureau of Science, and the present paper, therefore, makes no claim to be complete, but is merely a compilation of observations which the writers have made from time to time during the past two years.

THE NIPA PALM

Although nipa is usually described as having a branching rootstalk or rhizome, the consequences of this fact are not always realized. Perhaps it is more accurate to say that the consequences are not exactly known at the present time. Gibbs seems to assume that the nipa has a definite life period,[3] but the writers have not been able to find any evidence of a natural decline or death of the plant. The decay that can be observed can hardly be called the death of the plant, but is rather a continuous pro-

[1] Gibbs, H. D., Philip. Journ. Sci. § A **6** (1911) 99–206.
[2] Pratt, D. S., and others, Philip. Journ. Sci. § A **8** (1913) 377–398.
[3] Philip. Journ. Sci. § A **6** (1911) 116, 117.

cess of decay at one end of the underground trunk, which occurs while the other end is vigorously growing and dividing.

The division of the underground trunk is symmetrical and regular. Very soon after germination the underground stem begins to branch, which is shown by the fact that the leaves develop from two buds, or growing points. These buds grow farther and farther apart as leaf stalks accumulate between them, and each divides again after about two years. (See Plate 1, fig. 2.) When the four- or five-year-old tree begins to bear fruit it has four growing points, which are about a meter apart and form a rough square; these later divide into eight. Plate 1, fig. 3, shows a palm of eight buds or, more probably, a part of a palm of many more buds, which is beginning further division. The clump in the foreground and that in the background were originally one plant, though at the time of the picture the connecting underground trunk had probably rotted away. There is no way of telling how far away these palms are from the original place of germination, but they seem to represent not more than one-half of the total growth from one seed.

A nipa palm does not attain to full height until it is about ten years old, but at this age it apparently reaches a stable state of continuous growth and division at one end of the trunk and decay at the other. So far as the writers can ascertain a cultivated nipa grove is never replanted. Whether a very old grove gives less or more tuba than a young one cannot be stated accurately from available data, but the difference if any is not great.

The difference between nipa groves in different regions is marked. The writers' experiments have been confined chiefly to Manila Bay, Capiz, and Catarman, Samar. The Manila Bay swamps are characterized by their generally cultivated condition. The estimate of 30,000 liters of tuba per hectare [4] seems to be higher than is commercially realized on the average, though yields as high or higher are obtainable from small sections which bear well. The tendency of nipa to bear fruit varies a great deal according to the care of the grove (thinning of the nipa and elimination of underbrush) and other influences not so well understood.

The Capiz nipa is characterized by markedly larger leaves than are seen in Manila Bay. The size of fruits and quantity

[4] Pratt, op. cit. 379.

of tuba from each stalk also seem to be greater. The number of fruits per hectare, however, in the Capiz swamps that were visited is much less than that in the Manila Bay swamps. This is probably because the Capiz swamps have not been extensively used for tuba for a number of years and have been allowed to become dense. The quality of the tuba is about the same (15 per cent sugar) in both places. Just why the Capiz swamps have a sturdier growth is not evident.

The relatively small nipa swamps near Catarman are affected by the strong ocean tides, which cut out deep, narrow channels. This is unfavorable to nipa, as much of the swamp is too high for it and is covered with grass and other dry-land plants (Plate 2, fig. 1). The channels themselves are too deep for the nipa, which is forced to grow on steep banks (Plate 2, figs. 2 and 3). In spite of this fact, and of the crowded condition of the swamps, fruits were found to be plentiful, but the tuba was found to be of poor quality (10 to 12 per cent sucrose).

Besides these general differences between swamps, the plants in a given swamp vary considerably in yield and quality of tuba. How much of this is due to environment and how much can be controlled by a proper selection of seed is a question for valuable but rather tedious experimental work.

Another interesting and important point is the preparation of the fruit stalk for tuba flow. Gibbs says:[5] "According to native superstition the stalk must be kicked, in passing, once a week for five weeks, before it is cut or the sap will not flow freely." The experiments of the writers incline them to believe this "superstition." Several unprepared fruits of different ages which were cut left only dry stalks which did not give a drop of tuba in any case.

PRESERVATION OF TUBA

The very rapid disappearance of crystallizable sugar in tuba is undoubtedly due in large part to enzymes or zymogen[6] present in the sap itself. Without the help of microörganisms, however, these enzymes are not very effective. The fresh juice is practically neutral to phenolphthalein, sometimes giving a slight color, which shows that it is not a favorable medium for the action of invertase. Yeast and bacterial life, however, are very

[5] Philip. Journ. Sci. § A 6 (1911) 116, but cf. Conrado, A., and Zóbel, E., Estudio de la planta llamada nipa. Imp. de la Concepción, Manila (1906) 12.

[6] Gibbs, op. cit. 124; Pratt, op. cit. 382.

vigorous in a nipa swamp and often attack the tuba even before it drops from the stalk. If a strip of red litmus paper is laid against the cut end of a stalk, from which tuba is coming fairly rapidly, it is turned blue. If, however, a portion of the cut end is giving sap only slowly, that portion will turn blue litmus red. In case the flow is very slow the resulting tuba is strongly acid, and a characteristic white gelatinous deposit forms, in which yeast and bacteria develop rapidly.

Similar rapid fermentation and gelatinous precipitate may always be observed in the ordinary *tuquil*[7] used for collecting tuba. This may be reduced to a certain extent by using clean tuquils, especially in the first days of flow, during which the tuba evidently does not contain as much enzyme as later. This fact enables the tuba gatherers in certain swamps to make sirup or noncrystalline sugar from the first few days' flow, collected in clean tuquils. It has been found possible at the Catarman Agricultural School to extend the sirup making throughout the time of flow if the tuquils are washed, disinfected with lime, and placed on the palms in the late afternoon. The night tuba, collected in the early morning, is boiled down to sirup, and the day tuba is used for vinegar.

This sirup-making process is practically the same as that used in India to produce 300,000 tons of crystallized palm sugar annually.[8] The composition of the palm sap (from the wild date and the toddy palm) is about the same as that from nipa, but it may be that the enzymes are not so active. The lower temperature of the Indian groves during the collecting season is doubtless an important factor. At any rate, the Indian palm sap gives crystallized, though impure, sugar, while Philippine nipa tuba, treated in the same way, gives only a sirup or caramel.

Fermentation of tuba may be practically obviated by the precautions mentioned, but inversion, that is, conversion of the crystallizable sucrose into an uncrystallizable mixture of fructose and glucose, is not so easily prevented. Unless a preservative is used the boiled-down tuba is at best an edible sirup or noncrystallized caramel.

PRESERVATION WITH TOLUENE

The experiments with toluene described below were not undertaken with any idea of the commercial use of toluene, but rather

[7] The Pampangan name for the bamboo receptacle which is hung on the palm stalk. Visayan names are *lacob* and *salud;* Spanish, *bonbon.*

[8] Annett, H. E., and others, Memoirs Dept. Agr. in India, Chem. Series 2 (1913) 281-389; 5 (1918) 68-116.

as a good method for the chemical study of tuba. Since the completion of these experiments, however, toluene has become much cheaper, and its use may perhaps be considered as a commercial possibility. An advantange of its use is that it preserves the palm flavor and prevents darkening of the sap.

An experiment on the preserving power of toluene was made in a cultivated Pampanga nipa swamp. Three groups of palms, the fruits of which had been cut at different times, were chosen, and bottles containing 7 cubic centimeters each of toluene were placed on ten palms of each group. The polarization of the tuba was tested after collection for one-half hour. In the A group this was done immediately in the swamp, but this was found to be unnecessary, and the others were analysed a few hours after collection. Group A, which had been producing tuba for about seventy-five days before the experiment, showed by direct polarization 10.6, 10.7, 10.8, 11.7, 11.8, 11.8, 12.3, 12.3, 13.1, and 13.3 per cent sucrose. Group C, cut about forty days before the experiment, showed 13.6, 13.6, 13.8, 14.3, 14.6, 14.7, 15.3, 15.4, 15.6, and 16.1 per cent sucrose. Group D, cut eleven days before the experiment, showed 13.2, 13.2, 13.4, 13.9, 14.6, 14.8, 14.9, 15.4, 15.7, and 16.1 per cent sucrose.

The behavior of composite samples from these groups on preservation under a layer of toluene is shown in Table 1. It may be seen that inversion took place slowly. Meanwhile the Brix of the five samples, 14.8, 14.3, 17.2, 17.2, and 17.3, remained constant within the limits of error, and a very slight acidity to phenolpthalein appeared, in no case exceeding 0.02 per cent (as acetic).

TABLE 1.—*Percentage of sucrose in tuba preserved under toluene.*

Group.	Fresh.	Two weeks.	Six weeks.	Remarks.
	Per cent.	*Per cent.*	*Per cent.*	
A	11.9	9.1	5.9	Filtered.
A	12.0	10.0	6.7	Not filtered.
C	14.9	14.2	12.5	Filled to the cork with toluene.
C	14.9	14.1	12.7	Thin layer of toluene.
D	14.6	13.0	10.1	

The quality of the tuba seems rather poor for Pampanga, probably because the work was done in March, which is not the natural tuba season in that province. These palms had been tapped late in order to lengthen the season.

Following a suggestion by Gibbs,[9] that the development of the tuba invertase from a zymogen may require air, various experiments were tried with inert oils, such as kerosene, instead of toluene. Since these were found to have little inhibitory effect on the fermentation, it seems that the main action of toluene is as an antiseptic, and that inversion of tuba takes place only very slowly unless assisted by yeast or bacteria.

LARGE-SCALE COLLECTION OF TUBA

Due to the high price of toluene at the time of experimentation little beyond laboratory-scale work has been done with toluene. As mentioned above, a very light liming of the tuquil, not sufficient to interfere with the edibility of the product, checks the yeast but does not prevent inversion. A heavier liming, as advised by Gibbs,[10] necessitates subsequent removal of lime from the tuba. In March, 1920, an experiment was conducted to test the effectiveness of heavy liming. The tuba was collected in Pampanga and transported to Manila for removal of the lime and boiling to sugar.

TABLE 2.—*Collection data on limed tuba.*

	Group.			
	A	B	C	D
Age of stalk ......days..	65	45	30	2
Number of palms	34	31	55	90
Duration of experiment......days..	16	13	9	9
Average daily yield per palm ......cc..	630	773	581	500
Sucrose...... per cent..	9.0	10.1	9.1	10.7
Alkalinity (as CaO)......do....	1.3	1.4	1.4	1.3
Unlimed......per cent sucrose..	12.0	....	14.9	14.6

Preservative.—Due to the tendency of lime to sink to the bottom of the tuquil and allow the top layers of tuba to become acid, it was found necessary to use very heavy liming or else collect twice a day. A thick lime cream was made of density 50° Baumé, containing about 600 grams of lime (calculated as calcium oxide) and 25 grams of sodium bisulphite per liter. A liter of this mixture was poured into each tuquil and poured out again, about 200 cubic centimeters adhering to the tuquil. The tuquil was then placed horizontally and allowed to dry. The liming was done at a central place to which the used tuquils

[9] Op. cit. 124.

[10] Loc. cit.

were brought every day, and a freshly limed tuquil was placed every day on each palm after collection of the tuba. By this very thorough liming good preservation was obtained, and the top layers of tuba in each tuquil were almost always found alkaline to litmus even when collected at twenty-four-hour intervals.

The collection data are summarized in Table 2, in which the palms are grouped according to the age of the stalk; that is, the number of days that elapsed between the cutting of the fruit and the beginning of the experimental collection. The unlimed tuba mentioned in the last line of Table 2 was collected at about the end of the experimental period from ten representative palms in each group. Its collection, under toluene, has been described above.

The limed tuba was stored in wooden barrels for about a month before boiling to sugar, during which time absolutely no decrease in polarization could be detected. The alkalinity also was practically constant, but fell off about 0.1 per cent in a barrel of mixed A and B tuba.

It is evident that lime is more effective than toluene in preventing inversion on long storage. The discrepancy between the original values of the limed and the unlimed tuba is therefore surprising. It is partly due to the diluting effect of the lime cream, and perhaps partly to the formation of insoluble lime sucrate. For this and other reasons, such as the accumulation of lime on the tuquils, it was decided that such heavy liming was not practical. This point will be discussed later in connection with the use of funnels.

Manufacture of sugar.—After transportation to Manila the barreled tuba was freed from lime by carbonatation with compressed carbon dioxide and boiled to massecuite in a crude vacuum evaporator. The data on the sugar making [11] are given in Tables 3 and 4. In all 844 liters of tuba were boiled down, and 67 kilograms of sugar polarizing at 87 per cent were obtained. No difficulty was found in refining a portion of this sugar to a pure white product.

COLLECTION WITH FUNNELS

The disadvantages of very heavy liming have already been pointed out. If a thin lime cream is used to line the tuquils, however, the top layers of tuba in some of the tuquils become acid and ferment several hours before collection. Aside from the attendant loss of sugar the organic acid thus formed holds lime

[11] This work was done with the assistance of Mr. Salvador Sevilla.

TABLE 3.—*Manufacture of first sugars.*

	Run No.—						Total.
	1	2	3	4	5	6	
From tuba (chiefly)	B	A, B	A, B	A	C	D	
Total ....liters	181	80	120	90	188	185	884
Sucrose ....grams per liter	119	107	107	108	133	125	115
Sugar obtained ....kilograms	12.9	3.3	5.55	none	12.95	12.65	54.35
Sugar ....grams per liter	71	41	47	0	69	106	64
Polarization	89.6	90.5	91.6	....	89.1	88.9	89.5
Clerget sucrose ....per cent	89.3	90.1	91.7	....	89.1	88.5	89.3
Sucrose recovered per liter of tuba ....grams	63	37	43	....	61	94	57
Yield ....per cent	53	35	40	0	54	75	50
Molasses ....kilograms	7.65	9.05	9.45	15.45	11.93	10.55	64.1
Molasses per liter ....grams	42	113	79	172	64	57	76
Polarization ....degrees	46.7	46.5	45.5	50.6	48.3	45.7	47.4
Clerget sucrose ....per cent	42.3	41.1	41.1	47.4	47.0	44.2	44.4
Molasses sucrose per liter of tuba ....grams	18	46	32	82	30	25	34
Lost sucrose per liter of tuba	38	24	32	26	22	6	24
Brix of molasses	81.5	78.5	75.8	....	80.8	82.3	79.9
Total solid in molasses	78.9	70.7	75.4	....	79.2	77.9	76.6
True purity	53	58	54	....	59	57	56.6

TABLE 4.—*Manufacture of second sugars.*

	Run.			Total.
	a	*b*	*c*	
Molasses taken ....kilograms	....	....	....	64.1
Sucrose ....per cent	....	....	....	44.4
Brix	....	....	....	[a] 80
Total solid ....per cent	....	....	....	[a] 77
Sugar obtained ....kilograms	2.15	3.3	7.15	12.6
Polarization	85.2	83.9	68.5	75.3
Clerget sucrose ....per cent	85.2	84.4	62.4	72.0
Sugar per liter of tuba ....grams	....	....	....	15
Sucrose per liter of tuba ....do	....	....	....	11
Final molasses ....kilograms	9.75	12.25	15.45	37.45
Polarization	45.9	39.2	39.9	41.2
Clerget sucrose ....per cent	42.4	37.2	38.1	38.9
Sucrose per liter of tuba ....grams	....	....	....	17
Brix	83.7	83.9	82.5	86.1
Total solid ....per cent	80.2	79.5	77.7	79.0
True purity	53	47	48	49.0
Original sucrose in final molasses ....per cent	....	....	....	15

[a] Approximate.

in solution which cannot be removed by carbonatation and interferes in the sugar boiling. Pratt [12] has pointed out that this is caused, not by insufficiency of lime, but by the fact that the lime sinks to the bottom and does not mix with the tuba. The use of funnels to lead the tuba to the bottom as recommended by him was found to be quite successful in reducing the lime required to a very small amount. The difficulty encountered was in the adjustment of the tuquil so as to cause all of the tuba to flow through the funnel. When the tuba drips nicely from the end of the stalk the funnel catches it, but tuba which runs down along the stalk seldom enters the funnel but either is lost entirely or runs down the inside wall of the tuquil. When even a few of the tuquils become contaminated with acid top layers in this manner, the resulting mixture is of poor quality.

A slight modification in the manner of attaching the tuquil funnel was found to obviate this difficulty. The new type of tuquil is not pierced with a hole for the stalk but is suspended by means of a piece of ordinary telegraph or heavy fence wire. Under the stalk, near the end, a small bib of galvanized iron catches all the tuba and drops it into the funnel. The wire is firmly held to the stalk by a wood or bamboo wedge placed between the upper loops of the wire and the stalk. The arrangement is clearly shown in Plate 3, figs. 1 and 2.

The cost of a funnel top, made from second-group lumber on a turning lathe, is about 20 centavos. This is very durable, especially if impregnated with paraffin before use. The stem, of small bamboo such as caña bojo, costs practically nothing. The hanger costs about 5 centavos, including the labor of making. The time required for attaching and detaching the hanger is somewhat more than for the simplest native method of attachment, but not so long as for the more complicated methods in use in certain places. The simplest method is to make a small hole in the tuquil, which fits so tightly on the stalk that no fastening is required. As this method has certain faults, such as frequent splitting of the tuquils, and loss of the same by tidal action, it is often supplemented with various devices, even to the extent of tying the tuquil to the stalk, which takes considerably more time than the attachment of the wire hanger.

SMALL-SCALE MANUFACTURE OF NIPA SUGAR

The tuquil hanger above described was developed during a series of experiments at Capiz, Panay, and at Catarman, Samar, on

[12] Op. cit. 392.

a practical method for open-pan boiling of nipa sap. The previous nipa-sugar experiments of the Bureau of Science have tended more toward testing the suitability of tuba for large-scale sugar-mill methods than to the development of the industry in a small way. A large investment of capital in a nipa swamp on the basis of laboratory data alone, however, would be unsafe, and our recent efforts have been to develop a method that would be feasible on a small scale with a small investment.

The use of open pans, or *cauas*, instead of vacuum apparatus makes the boiling house inexpensive, but the replacement of a large-scale carbonatation equipment by home-made apparatus is more of a problem. The Indian method of using so little lime that it need not be removed does not seem efficacious in Philippine nipa swamps, so carbonatation or some equivalent process must be employed.

A small-scale carbonatation outfit recently set up at Catarman is shown in Plate 3, fig. 3. Charcoal is burned in a tight clay stove, a small blacksmith's forge supplying the draft. The fumes are conducted through a 10-inch stovepipe filled with stones. Limed tuba is allowed to trickle down this tower, the same tuba being run through about four times. The carbon dioxide from the burning charcoal precipitates the lime as carbonate, and the heat is generally sufficient to cause the precipitate to flocculate, or "break," especially if the tuba is run through slowly the last time. The hot liquid is filtered through sand placed in kerosene cans having pierced bottoms, and the clear filtrate boiled down in open pans.

The yield of crystalline sugar at the Catarman plant has so far not been good, apparently because of the low-grade tuba from the wild swamp there. The study of tuba variation and of small-scale utilization of tuba is being continued.

Acknowledgments and thanks are due to Ayala & Co.; Mr. José Hernández, of Capiz; and Mr. Wiren, of the Catarman Agricultural School, for the coöperation which has made possible the experiments mentioned in this paper.

ILLUSTRATIONS

PLATE 1

FIG. 1. A nipa seedling.

2. A two-year-old nipa palm. The seed and first leaf can be seen at the right of the clump of leaf stalks.
3. A typical mature palm. The clumps in the foreground and in the center of the background were originally the same plant. A month or two previous to the picture the portion at the left had been razed nearly to the ground, but the plant is rapidly recovering.

PLATE 2

FIG. 1. Typical mixed vegetation at Catarman. A deep tidal stream is responsible for the nipa in the center of the picture.

2. Nipa growing on a steep bank. The same tidal stream as in fig. 1.
3. Another portion of the bank shown in fig. 2.

PLATE 3

FIG. 1. Tuquils with wire hangers, on crowded nipa bank.

2. Typical palm, with wired tuquils.
3. Simple carbonatation apparatus. Evaporating furnace in background.

Fig. 1. A nipa seedling.

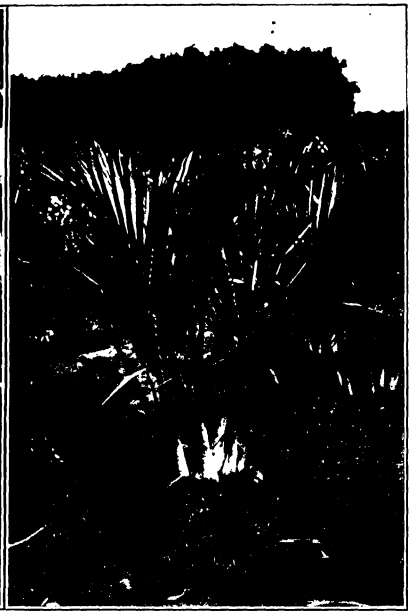

Fig. 2. A two-year-old nipa palm; the seed and the first leaf can be seen at the right of the clump of leaf stalks.

Fig. 3. A typical mature palm; the clumps in the foreground and in the center of the background were originally the same plant.

PLATE 1.

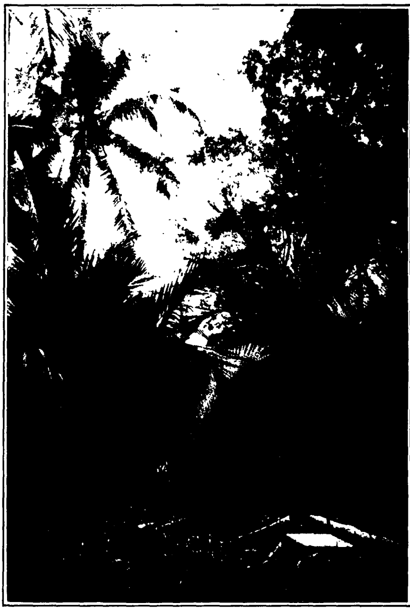

Fig. 1. Typical mixed vegetation at Catarman; a deep tidal stream is responsible for the nipa in the center.

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Fig. 3. Another portion of the bank shown in fig. 2.

PLATE 2.

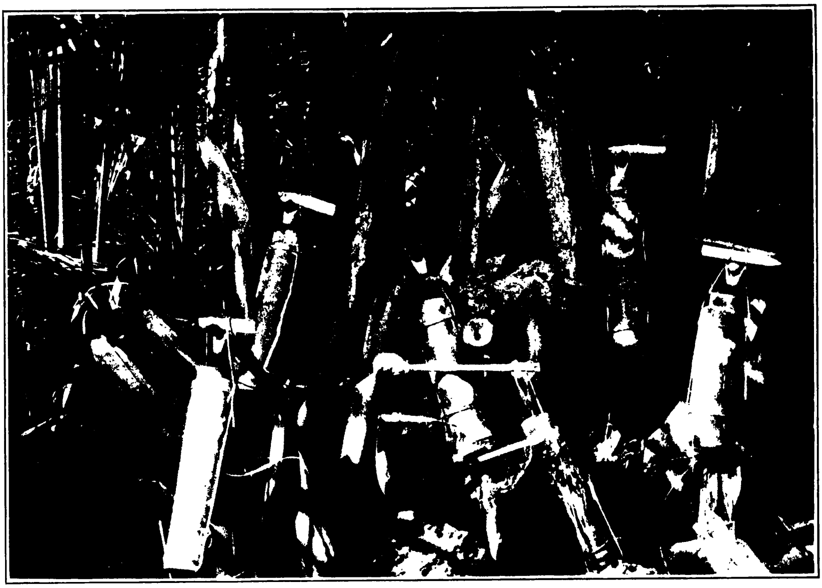

Fig. 1. Tuquils with wire hangers, on crowded nipa bank.

Fig. 2. Typical palm, with wired tuquils.

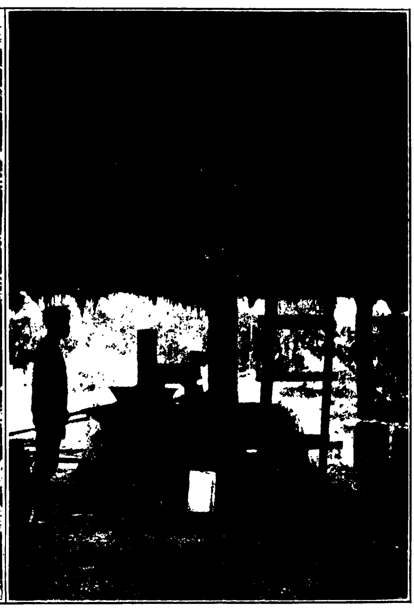

Fig. 3. Simple carbonatation apparatus; evaporating furnace in background.

PLATE 3.

DRAINAGE CONTROL BY JOINTING IN ANGAT DISTRICT, BULACAN PROVINCE, PHILIPPINE ISLANDS

By HUBERT G. SCHENCK

Of the Division of Mines, Bureau of Science, Manila

TWO PLATES

In making the trip north from Montalban, Rizal Province, to Angat River, Bulacan Province, Luzon, one is impressed from a distance by the nearly uniform elevation of the ridges and hilltops, and upon his first sight of Angat River the observer is apt to conclude that here is an old-age stream rejuvenated, judging from what appear to be numerous intrenched meanders, and that the country was once peneplained. A study of the topographic map of the region (Plate 1) apparently confirms this first field impression, for the hills vary from 300 to 400 meters in height, and winding rivers are evidenced. However, field work tends to disprove any theory of peneplanation that might be set forth and indicates instead that the drainage, in a limited area at least, is controlled by a definite system of joints in igneous rocks. It is the purpose of this paper to give reasons for this interpretation.

The field work upon which this paper is based was limited to an area between Montalban on the south and Angat River on the north (chiefly from Paila to Papaya on Angat River), while the writer was a member of a geologic party investigating a proposed dam site for the Metropolitan Water District of Manila. The region is essentially an igneous one, although some Miocene limestone outcrops in Ipu River, at Papaya, near Pinagkamalejan Barrio (Pinagkamaligan) between Ipu and Paila, and near Sicao. The principal rocks, however, are andesites, andesitic agglomerate, and basalts, though diorite and silicified intrusive masses are known. Most of the igneous formations are younger than the Miocene limestone.

The immediate area under discussion is not one of high relief, few peaks reaching a height of more than 400 meters, while the lowest valleys have elevations ranging around 100 meters above sea level. To the east rise the high peaks of the Eastern Cor-

dillera. The soil is residual, except in a few favorable places in valleys where it is transported. Spurs are usually of hard material. Angat River and all the creeks are youthful. Erosion has taken place in the zone of fracture and carved the earth's surface to that stage of erosional cycle which may be termed early maturity in the andesitic areas and more-advanced maturity in the limestone areas.

To account for the physiography of this limited area, one first tries the idea of peneplanation, and the writer was for some time convinced that this was the proper interpretation of the land forms. The reason for suggesting the theory at this time is that base levels have been suggested in the plateaus of northern Luzon and elsewhere, and it is possible that a discussion in the nature of the present paper might fit into a general scheme where there may be several such base levels; or, on the other hand, it might explain certain land features by other means than by that of peneplanation. The six principal criteria, or evidences, of peneplanation are deep rock weathering, absence of ledges, absence of undrained areas, monadnocks, lack of interruption of peneplain surface on rocks of different resistance, and old-age drainage. Considering these separately, it is found that:

1. This criterion of peneplanation cannot be relied upon in the Tropics where weathering is normally very deep.

2. Ledges in this district are very abundant, and are quite evident, even though there is the usual tropical vegetation. This also does not apply in the district under discussion.

3. This section is well drained, and no undrained areas were noted, as might be expected.

4. A monadnock is an erosional remnant, usually of resistant material, left standing during the process of a river's reaching base level. No monadnocks were seen, and the idea that Mount Mararat might be such is not plausible, since it does not have the softened contours of a monadnock, but is probably a mass of andesite of the same age as the formation in which the river is to-day entrenched.

5. This cannot be stated definitely but is based on good evidence that some of the ridges extant are of a hard, silicified material, while some are harder and more resistant than the other rocks and have been, and are being, eroded faster than the more durable formations, indicating an interruption of a peneplain surface.

6. That Angat River meanders to a very large extent and bears a superficial resemblance to a rejuvenated old-age stream cannot be gainsaid, though it should be pointed out that the elbow bends made by the river are not true old-age meanders, while the apparent uniform level of hilltops is due merely to the removing of burden from the top of a lava flow and the smoothing off of the original surface, and therefore the accordance of tops is not indicative of a peneplain surface. This, nevertheless, is not due to base-leveling during an earlier erosional cycle, but as evidence gained in the field indicates is due to three principal causes; namely, jointing, difference in hardness of rock, and faulting.

The major systems of jointing seem to be northeast–southwest and northwest–southeast with minor north–south and east–west ones, but no reliable general inclinations of the systems were observed, nor could the spacing be determined in so short a time. The joints are frequently stained by iron oxide and, at places, are very definite. Ickis [1] found that the jointing of the andesite in Agos River from Infanta as far west as Macadata was about north 75° east, with a dip of 75° to the southeast, and that there are also joints that strike nearly at right angles to these and dip steeply to the northeast. The same observer also records joints striking north 20° west to north 70° east. The joint system in the vicinity of Paila, as noted by the present writer, varies from north 20° west to north 40° west, and at right angles thereto. Near Papaya, the major jointing appears to be north 50° east to north 60° east. At the head of a creek near Paila, a good north 35° west joint was noted, while in a creek near Metropolitan Dam Site 2 there is a good example of the northeast joint system. Below Dam Site 1, the river turns sharply north 30° west after cutting a northeast box cañon through a hard, silicified dike.[2] Other examples of this feature might be pointed out, and the writer believes that the main drainage is roughly parallel to the major systems of jointing and is largely controlled by them.

The second cause of the apparent old-age drainage of Angat River is difference in hardness of rock. Incipient stream cap-

[1] Ickis, H. M., A geological reconnaissance from Infanta, Tayabas, to Tanay, Rizal, Philip. Journ. Sci. § A 4 (1909) 483–487.

[2] This detail does not show on the map presented herewith, because the map is more or less generalized.

ture is hindered, if not prevented, by this. For example, if the creek at Dam Site 2 could work headwards with ease, it might capture Sapang [3] San Lorenzo and also the drainage of the main river, but this is partly prevented by hard, silicified andesite that acts as the divide here. A hard dike turns the river near Paila between Dam Sites 1 and 2, as is shown on the map. As a rule bends in the river are actually more abrupt than shown on the map.

As a third important cause of the extraordinarily abrupt bends of Angat River, one must record faulting and the fact that the faults may be in conformity with the joint system. Faulting probably accounts for the short change of course upstream about 6 kilometers from Papaya, where the long southwest flow is changed for a short distance only, and where other evidences of faulting are to be noted.

These three causes of drainage control have combined with one another at places to bring about the present land forms. At the entrance of the gorge below Paila, at Dam Site 1 (Plate 2, figs. 1 and 2) the jointing is north 30° west, as is likewise the strike of beds of andesite and agglomerate, and here, working up a joint in the least resistant material, is a small stream, showing that erosion is aided by both the nature of the rock and the joints. At another place near Ipu River a valley is developing along what appears to be a fault, while at still another locality (near the dam sites) a fault parallels the jointing and reenforces the joint-system control. But when all is considered and more observations are recorded, the writer believes that jointing will best explain the majority of drainage features.

These systems of jointing are by no means unusual, for it is well known that there is a tendency for fractures to intersect at right angles to one another and for all the sets to be at about 45° to the direction of compression. It is, however, in the world relationships that the northwest–southeast and northeast–southwest jointing of Angat district is most interesting. For instance, Iddings [4] records similar drainage control in the region north of the Yellowstone National Park in the United States, while Hobbs [5] discusses this matter of structural control of drainage (and

[3] *Sapa*, becoming *sapang* in combination, is Tagalog for "creek."

[4] Iddings, J. P., A fracture valley system, Journ. Geol. 12 (1904) 94–105.

[5] Repeating patterns in the relief and in the structure of the land, Bull. Geol. Soc. Am. 22 (1911) 123–176.

the influence which Hobbs considers predominant in Europe and Africa is practically the same as the jointing observed by the writer in this locality in the Philippines) and concludes that a recognition of such a fracture system "points inevitably to the conclusion that more or less uniform conditions of stress and strain have been common to probably the earth's entire outer shell."

It might be argued that the three factors of drainage control discussed herein are perhaps subsidiary to a main control; namely, that the entire river is not controlled by jointing, faulting, and differential hardness of rock, but by other factors such as antecedency and superimposition, taking as evidence for this stand the general south course of the river and the turn it makes to the west later. Another criticism that can well be advanced is that not enough territory was covered to gain an idea of the entire area. The writer admits the truth of these points, but he desires to make it clear that he is convinced that in the small, limited district in question northwest–southeast and northeast–southwest jointing systems, aided by faulting and hardness of rock, control the drainage, and that here this peculiar feature is not the result of peneplanation and subsequent rejuvenation.

ILLUSTRATIONS

PLATE 1. TOPOGRAPHIC MAP OF ANGAT DISTRICT.

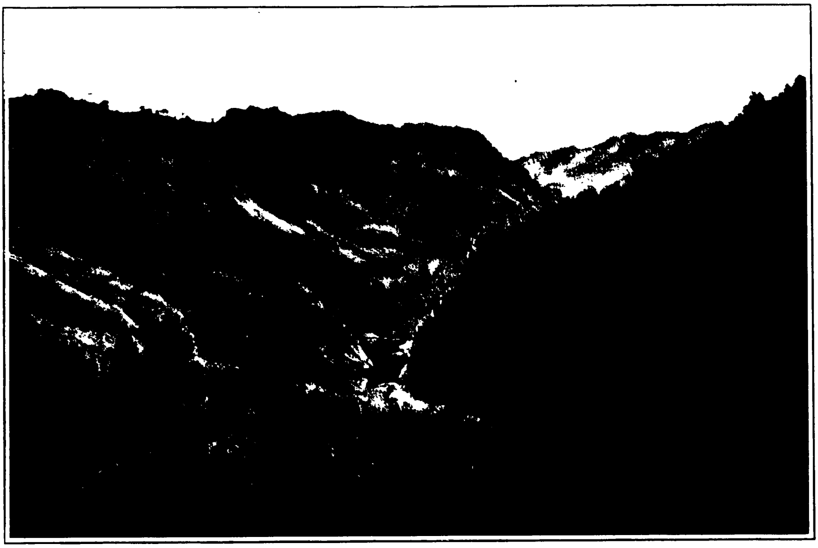

Fig. 1. Angat River, looking westward toward Dam Site 1, where the river cuts a box cañon and turns sharply north 30° west.

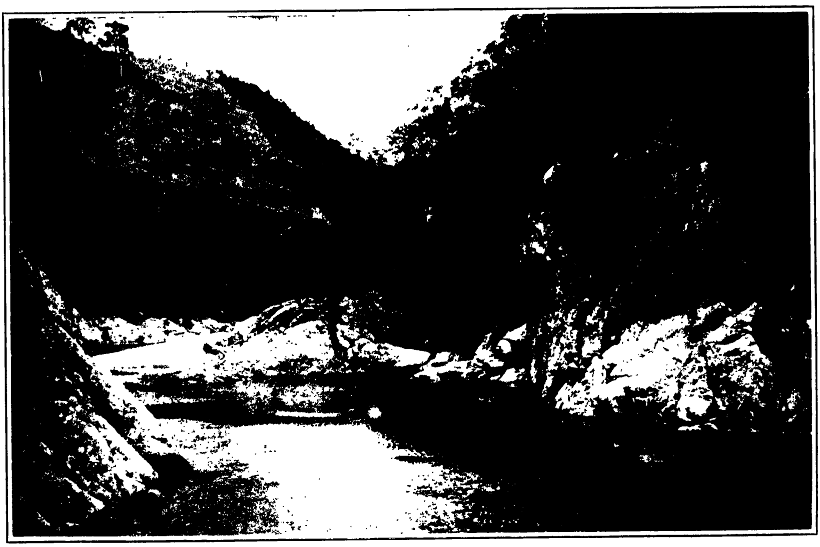

Fig. 2. Angat River, Dam Site 1.

PLATE 2.

PHILIPPINE SERPHIDÆ (PROCTOTRUPIDÆ)

By J. J. KIEFFER

Professor at Bitche, Lorraine, France

[Translated from the German by Anna B. Banyea, of the Bureau of Science, Manila]

BETHYLIDÆ

The species here described were collected by Prof. C. F. Baker, in the Philippines, on the islands of Luzon, Mindanao, Negros, Leyte, and Palawan.

ANTEONINÆ (DRYININÆ)

Genus **ALLODRYINUS** novum

Head strongly oblique, slightly convex dorsally. Eye bare. Palpi very short, only one short joint prominent. Antennæ 10-jointed, distally hirsute. Prothorax almost cylindrical, elongate, much longer than mesonotum, this strongly transverse, with continuous parapsidal furrows which diverge in front and are separated from each other posteriorly by three times their breadth. Scutellum in front with a deep cross furrow. Metanotum depressed, forming a narrow cross stripe. Median segment horizontal, nearly as long as broad, dorsal surface traversed by a deep, broad, median groove; smooth and shining laterally and divided into areas by a few raised lines. Posterior surface almost vertical, separated from the anterior surface by an irregular transverse carina, with a large, median, longitudinal area and laterally one or two smaller areas. Venation as in *Lestodryinus*. Pterostigma very narrow, lanceolate.

Front leg extraordinarily long, extending much beyond abdomen, coxa obconical, as long as femur; trochanter also as long as femur, thin, pedicellate, thickened in the distal half; femur shaped like coxa, tibia thin, gradually thickened in the distal half, tarsus longer than tibia, first and fourth joints long, fourth longer than the first three combined, fifth small, chelæ slender, extending to third joint, both branches of chelæ almost straight, incurved at end, without tooth but with rows of lamellæ or spines, median branch (which is a continuation

of fifth tarsal joint) with truncate lamellæ, without spines, lateral branch, which is the inflexed claw, with about ten spines equidistant from each other, with much longer, curved bristles on the inflexed distal end.

Type, *Allodryinus miripes* sp. nov.

Allodryinus miripes sp. nov.

Female.—Black, shining, smooth. Head whitish, dorsally black from posterior margin to opposite anterior third of eye, the black marking arcuate in front, truncate behind. Viewed from above the head is strongly transverse, almost twice as broad as long and almost twice as broad as prothorax, dorsally slightly convex, marginate behind, the entire posterior margin strongly curved and notched, occiput sloping and excavated. Vertex and frons at least as broad as length of eyes. Cheek one-fourth as long as eye, with fine, silvery white hairs like the anterior part of frons. Eyes more than twice as long as broad, weakly divergent behind. Ocelli forming an equilateral triangle. Mandible whitish, with three brownish teeth. Antenna 4 millimeters long, very thin, first and second joints whitish, second fully two to three times as long as thick, third taking in more than one-third of the entire flagellum, sixth as long as the following three united, ninth twice as long as thick, shorter than tenth, seventh to tenth hirsute, the hairs longer than the thickness of joints.

Prosternum whitish, a small, circular spot behind on pronotum as well as scutellum yellowish. Prothorax almost cylindrical, twice as long as broad, the posterior margin extending laterally lobelike to tegula. Mesonotum twice as broad as long, very finely punctured, parapsidal furrows diverging anteriorly, separated from each other posteriorly by three times their breadth. Cross furrow of scutellum black. Wings hyaline, pterostigma very long and narrow, radial curved, long, reaching almost to anterior margin, postmarginal slightly shorter than radial, basal oblique, twice as long as transversal, arising in the distal end of subcostal, nervule nearly vertical, medial extending somewhat beyond basal cells.

Legs whitish to pale yellow, almost transparent, foreleg much longer than body, 8 millimeters long, petiole of hind femur a little shorter than the clava, tibia almost filiform, longer than femur. Abdomen as long as rest of body, venter testaceous.

Length, 5 millimeters.

MINDANAO, Butuan.

Genus HAPLOGONATOPUS Perkins

Haplogonatopus cristatus sp. nov.

Female.—Black, smooth and shining. Head more than twice as broad as long, strongly excavated dorsally, with a continuous median longitudinal carina, notched and arcuate posteriorly. Eye bare; ocelli wanting; clypeus and mandible white, the latter with three black-brown teeth. Palpi not prominent. Antenna unicolored, scape very much widened ventrally, second joint a little shorter than first, not twice as long as thick, third almost twice as long as first and second combined, distally gradually thicker, fourth gradually thickened, two-thirds as long as third, the following ones of equal thickness, gradually shortened, ninth fully twice as long as thick, shorter than the last one. Thorax much narrower than head, the forward node raised pectinate medially, compressed laterally, anteriorly gradually rising, posteriorly falling away steeply; posterior node oblong, noticeably longer than the anterior, posteriorly coarsely and closely transversely striated, the thorax lightly fastened between both knots. Wings wanting.

Tarsal joints 2 to 4 red-brown; coxa of foreleg elongated, trochanter clavate, half as long as femur, with a long, thin petiole, femur much thickened in the proximal three-quarters; metatarsus long, second, third, and fifth joints very short, fourth at least as long as first, the medial branch of chelæ, or continuation of fifth tarsal joint, reaching distal end of metatarsus, straight, with a row of close lamellæ, incurved at distal end; lateral branch of chelæ curved and tapering in the distal third, without tooth; proximal half with four lamellæ situated equidistant from one another; hind femur thick in proximal third only, shorter than the thin tibia. Abdomen smooth.

Length, 6 millimeters.

NEGROS, Cuernos Mountains.

BETHYLINÆ

Genus CLADOBETHYLUS novum

This genus is distinguished from all other Bethylinæ by the shape of the head and of the antenna. Viewed from above the head is somewhat transverse, falling away abruptly in front; seen from in front it is higher than broad at top, gradually narrowing below to the mandibles. Mouth directed downward, mandible narrow, almost lineal, scarcely emarginate at the end. Eye very large, very prominent, almost semiglobose, and bare.

Antenna 13-jointed, originating close behind mouth, geniculate as in the Ceraphroninæ.

Pronotum as broad as mesonotum, quadrangular. Mesonotum with two continuous parapsidal furrows. Scutellum strongly transverse, rounded behind, not impressed in front. Median segment almost horizontal, slightly convex, with two broad crenulated furrows which converge posteriorly and come together at the posterior margin, thus inclosing a three-cornered field, laterally and posteriorly bordered by a crenulated groove; posterior surface almost vertical. Venation of forewing as in *Epyris*, but radial shorter; hind wing without veins, lobed behind. Legs as in *Epyris*, claw very small. Abdomen flat, shorter than usual, elliptic, petiole very small, originating between hind coxæ, second tergite falling away in front almost vertically, third scarcely longer than second, the three following ones short.

Type, *Cladobethylus cruciger* sp. nov.

Key to the species of Cladobethylus g. nov.

a^1. Head and thorax black, without metallic sheen, hind tibia bare. C. myrmecophilus sp. nov.

a^2. Head and thorax blue, with metallic sheen, hind tibia with long hairs dorsally.

  b^1. Head with a smooth median longitudinal line, postmarginal wanting, third tergite without punctation........ C. cruciger sp. nov.

  b^2. Head without smooth longitudinal line, postmarginal present, third tergite closely punctured........ C. cœruleus sp. nov.

Cladobethylus myrmecophilus sp. nov.

Male.—Black, smooth, shining; face and mouthparts yellow, palpi and legs whitish, almost transparent, second antennal joint, posterior margin of scutellum, petiole, and second tergite red-brown. Head with few coarse punctures, quadrangular when viewed from above, slightly transverse, scarcely broader than thorax, falling away almost vertically in front to antennæ and gradually narrowing, laterally higher than long. Eye bare, large, round, as wide as frons, almost reaching posterior margin of head. Posterior ocelli opposite middle of eye, separated from eye by their diameter, widely separated from posterior margin of head. Cheek almost lacking. Palpi very small. Antenna geniculate, as long as body, thin, filiform, scape scarcely shorter than third joint, second joint very small, bare, little longer than thick, third to thirteenth with short hairs, gradually becoming thinner and shorter, third fully five times as long as thick, twelfth scarcely three times, thirteenth a little longer.

Thorax almost three times as long as high, sublinear. Pronotum quadrangular, transverse, slightly convex. Mesonotum as long as pronotum, quadrangular, with continuous, parallel, widely separated parapsidal furrows. Mesopleura coarsely, scatteredly punctured. Scutellum transverse, two-thirds as long as mesonotum, quadrangular. Metanotum lacking. Median segment opaque, irregularly rugose, not edged, but convex laterally and posteriorly, strongly transverse, as high and as broad as pronotum and mesonotum; two oblique longitudinal striæ from anterior margin to posterior margin, where they join, forming two tiny teeth.

Wing faintly fuscous, subcostal lying close to costal, pterostigma narrow, lanceolate, longer than the short postmarginal, radial very short, only two-thirds as long as basal, extended almost to the anterior margin by a long, curved, pale vena spuria, basal oblique, arising in the thickened end of subcostal, transversal vertical, half as long as basal, medial reaching beyond the basal cells and thus bordering an outer submedian cell above, the two other veins (distal and posterior) bordering it very pale, discoidal continuous, cubital extinct anteriorly, distinct in the distal two-thirds; hind wing shortly lobed, without veins. Legs bare, femora slightly thickened, tarsi slender, 5-jointed. Abdomen rather flat, elliptic, somewhat shorter than thorax, shaped as in the preceding.

Length, 2.8 millimeters.

MINDANAO, Butuan.

A dead ant was found firmly attached to the ventral surface of abdomen. This ant was 1.2 millimeters long, pale yellow; head (exclusive of the quadridentate mandibles and the eleven-jointed antenna) and abdomen (exclusive of petiole and the two knots) black; head quadrangular, somewhat elongate, broader than abdomen; mandible nearly half as long as head; third to eighth joints of antenna transverse and equally thin, ninth to eleventh thickened, eleventh as long as the six preceding ones combined.

Cladobethylus cruciger sp. nov.

Male.—Metallic blue. Head coarsely and rather closely punctured, as broad as thorax. Mandible yellow. Cheek with a deep furrow, half as long as eye, smooth, black and shining, like the anterior part of temple. Eye broader than frons, almost reaching posterior margin of head. Ocelli forming an equilateral triangle, the posterior ones separated from eye by their diameter, from each other by twice their diameter, lying almost opposite middle of eye, more than twice as far from posterior

margin of head as from each other. A smooth, longitudinal line connects the anterior ocellus with posterior margin of head, and a smooth crossline connects the posterior ocelli, thus forming a cross. Frons anteriorly with a weak, rather smooth impression. Palpi pale; maxillary palpus at least 4-jointed. Antennæ brown, geniculate behind scape, first and second joints yellow, scape as long as the following two joints together, second joint very small, ring-shaped, the following ones thicker, longer, cylindric, and hirsute, the hairs almost as long as thickness of joints, the third joint fully three and a half times as long as thick, the fourth three times, the following ones gradually shorter, the twelfth more than twice as long as thick, shorter than the last one.

Pronotum and mesonotum coarsely and rather closely punctured, the pronotum somewhat transverse, distinctly longer than mesonotum; this truncate anteriorly and posteriorly, the median part broader than the lateral ones, parapsidal furrows parallel. Scutellum not punctured. Metathorax black, shining; triangular field of median segment smooth, cross-wrinkled laterally, anterior margin of median segment with a row of small pits, posterior vertical surface with two longitudinal carinæ strongly converging downward. Metapleura flat, almost smooth, emerging toothlike above behind the middle; mesopleura convex, coarsely and closely punctured.

Wings faintly fuscous, subcostal near costal; pterostigma lanceolate; radial originating slightly distad of the middle of pterostigma, bow-shaped, proximal portion shorter than basal; distal portion supplanted by a pale, fine line and longer than the proximal portion, almost reaching anterior margin; basal very oblique, curved only at base, three times as long as transversal, arising in the distal end of subcostal; transversal almost vertical; postmarginal wanting; pale lines indicate the following veins and cells; the cubitus sinuous, arising from distal end of basal and reaching margin of wing; a continuation of medial to cubitus; a continuous anal; a closed distal medial cell (cubital cell); and a closed distal submedian cell (discoidal cell). Hind wings with four tiny frenulæ. Legs yellow, femur and tibia of hind leg dorsally with long, spreading hairs. Abdomen black-brown, smooth, second and third tergites long.

Length, 3.5 millimeters.

MINDANAO, Butuan. LUZON, Laguna, Mount Maquiling.

Cladobethylus cruciger var. antennalis var. nov.

Male.—Scape brown like flagellum, third joint three times as long as thick, fourth only twice as long. Mesonotum as long as pronotum. Triangular field of median segment metallic blue. Distal section of radial forming a distinct, fine vein. Abdomen dark red-brown to black-brown.

Length, 4 millimeters; otherwise like type.

LUZON, Tayabas, Mount Banahao.

Cladobethylus cœruleus sp. nov.

Female.—Like *C. cruciger* with the following exceptions: Head more finely punctured, without smooth longitudinal line or cross-line; posterior ocelli not twice as far from posterior margin of head as from each other; cheek scarcely one-third as long as eye, frontal impression finely cross-striped. Antenna without hairs, third joint two and a half times as long as thick, fourth longer by a half than thick, the following ones gradually thinner, twelfth one and a half times as long as thick, thirteenth more than twice as long as thick. Postmarginal distinct, thicker than radial, somewhat shorter than the proximal section of radial, basal sinuate; veins obsolete in *C. cruciger*, very plainly visible in the present species. Triangular field of median segment metallic blue; the posterior vertical surface traversed by a continuous middle field which is broad and curved-rounded above, and narrowed toward the bottom. The entire third tergite closely and rather finely punctured. Coloring as in *C. cruciger*.

Length, 4 millimeters.

MINDANAO, Butuan.

Genus ISOBRACHIUM A. Förster

a[1]. Median segment with 5 longitudinal raised lines. **I. bipunctatum** sp. nov.

a[2]. Median segment with 3 longitudinal raised lines. **I. luzonicum** sp. nov.

Isobrachium bipunctatum sp. nov.

Female.—Black. Head elongate, finely hirsute, closely punctured, opaque, much wider than thorax, widest at middle of eyes. Eye finely hirsute, short-elliptic, three times as long as cheek, as long as its distance from posterior margin of head; posterior ocelli touching posterior margin of head; mandible and palpus red-brown. Antenna dark-brown, scape black except the distal

end, as long as the three or four following joints together, second joint somewhat elongate, third to twelfth transverse, thirteenth elongate, all bare, second and third joints testaceous.

Pronotum elongate, opaque, closely punctured, somewhat wider behind than in front. Mesonotum scarcely more than half as long as pronotum, smooth, shining, transversely elliptic. Scutellum opaque, very finely punctured, anteriorly with two short oval depressions almost touching each other. Median segment quadrangular, distinctly longer than broad, bordered laterally and posteriorly by a furrow, finely coriaceous, with five parallel, contiguous, longitudinal carinæ in the middle, these somewhat shortened posteriorly, only the medial one continuous.

Wings scarcely fuliginous; basal and transversal equally long and equally sloping, the former originating in the distal end of subcostal; pterostigma linear in shape, the distal half consisting of a white proximal and a brown distal dot, the radial arising from the latter, the radial being three to four times as long as basal, slightly curved. Tegulæ and legs testaceous, coxæ black, femora brown except the distal end. Abdomen convex, smooth, shining, gradually tapering to a point.

Length, 3 millimeters.

MINDANAO, Butuan.

Isobrachium luzonicum sp. nov.

Female.—Black. Head almost circular, scarcely longer than broad, smooth, shining, with few close punctures, eye hirsute, one-third longer than occiput; palpi pale. Antenna dark red-brown to brown-black, bare; scape as long as the three following joints together, second joint somewhat elongate, third to twelfth scarcely as long as thick, thirteenth oblong. Pronotum somewhat longer than broad, smooth, shining, with rather large but not very close punctures.

Mesonotum two-thirds as long as pronotum, anterior half smooth, without punctures, posterior half finely and rather closely punctured. Scutellum without punctures, smooth and shining, the depressions separated from one another by a carina. Median segment as long as broad, transversely rugose, marginate laterally and posteriorly, with three continuous, contiguous longitudinal carinæ slightly converging behind; posterior surface vertical, smooth, with a median longitudinal carina. Mesopleura with few punctures; metapleura almost smooth. Wings slightly fuliginous; subcostal near to costal; pterostigma nar-

row, three times as long as broad, the proximal third white; postmarginal wanting, basal oblique, originating in the distal end of subcostal; radial three times as long as basal, transversal as long and as slanting as basal. Tibiæ and tarsi red; femora of the four hind legs black-brown, middle tibia laterally with short spines. Abdomen convex, conically tapering behind.

Length, 3 millimeters.

LUZON, Laguna, Mount Maquiling.

Genus **MESITIUS** Spinola

Mesitius philippinensis sp. nov.

Male.—Black. Like *M. luzonicus* Kieff.[1] except for the following markings; the coarse punctures of the head umbilicate; fourth to thirteenth joints of antenna more than twice as long as thick. Wings brownish, with a lighter crossband from pterostigma to posterior margin, veins and pterostigma black-brown. Legs black-brown, distal end of tibiæ and tarsi yellow; only the posterior fifth of third tergite without punctures, the two filiform appendages of the last segment converging.

Length, 3.5 millimeters.

MINDANAO, Dapitan.

Genus **CLEISTEPYRIS** Kieffer

a^1. Mandible much widened distally, 4- or 5-toothed; clypeus rounded in front or truncate.
  b^1. Veins and pterostigma pale yellow; postmarginal as long as pterostigma; twelfth antennal joint fully five times as long as thick.
    c^1. Claw with one small tooth; the four proximal antennal joints brownish yellow .... **C. intricatus sp. nov.**
    c^2. Claw with a large tooth, almost furcate; distal end of scape and second joint reddish brown .... **C. xanthopterus sp. nov.**
  b^2. Pterostigma as well as the greater part of veins black-brown.
    d^1. Postmarginal much shorter than pterostigma; median segment without longitudinal carina; 6 to 9 millimeters long.
      e^1. Head with thimblelike punctures; pronotum and mesonotum rather closely punctured; twelfth antennal joint not three times as long as thick .... **C. philippinensis Kieff.**
      e^2. Head without thimblelike punctures, the punctures rather close but not touching; pronotum and mesonotum with but few scattered punctures; twelfth antennal joint at least four times as long as thick .... **C. consobrinus sp. nov.**
    d^2. Postmarginal twice as long as pterostigma; median segment with a longitudinal carina; 3 to 5 millimeters long. **C. minimus Kieff.**

[1] Tierreich 41 (1914) 304.

a^2. Mandible almost linear, distally scarcely broader, obliquely truncate, and terminating in a single pointed tooth; clypeus triangular, strongly keeled, sharply projecting in front.................. C. minor Kieff.

Cleistepyris intricatus sp. nov.

Male.—Black, smooth, shining. Head almost circular, scarcely longer than broad, rather closely and coarsely punctured; eye bare, somewhat longer than occiput, posterior ocelli twice as far from posterior margin of head as from each other; cheek almost wanting. Clypeus keeled, truncate anteriorly. Mandible dark red-brown, distally very broad, coarsely punctured, with four or five dark-brown teeth which gradually increase in length from top to bottom. Palpi pale, maxillary palpus with five prominent joints. Antenna filiform, the four proximal joints brownish yellow; scape as long as second and third joints together, second joint bare, shining, almost annular, third little longer than fourth, this somewhat more than twice as long as thick, the following ones like the fourth, distal joints gradually becoming thinner, twelfth fully five times as long as thick, scarcely shorter than thirteenth; hairs almost as long as the thickness of joints, longer on distal joints.

Pronotum much widened dorsad, scarcely longer than mesonotum, both with few scattered punctures; parapsidal furrows parallel, not distinctly widened behind and not reaching the posterior margin. Scutellum without punctures, the cross furrow slightly curved, somewhat broader at both ends. Metanotum coarsely rugose. Median segment scarcely transverse, very coarsely intricately wrinkled, marginate laterally, not so posteriorly, posterior surface not vertical, coarsely intricately wrinkled and without a median longitudinal carina. Metapleura closely striped longitudinally; mesopleura scatteredly punctured.

Wings hyaline, with white branched lines; pterostigma lanceolate, yellow like the veins, white at base; postmarginal as long as pterostigma; basal very slanting, originating in the thickened distal end of subcostal; transversal slanting, shorter than basal; radial scarcely twice as long as basal; distal submedian cell bordered by pale venation. Tegulæ and legs testaceous; coxæ black; hind femora black-brown; femora slightly thickened; legs finely hirsute, joints of fore tarsus elongate, not heart-shaped; claw with one small tooth. Abdomen slightly convex, gradually narrowing behind, without punctures.

Length, 6 millimeters.

LUZON, Laguna, Mount Maquiling.

Cleistepyris xanthopterus sp. nov.

Male.—Black; mandible, distal end of scape, and second antennal joint red-brown; foreleg and middle leg testaceous, hind leg, coxa, and femur of middle leg black-brown. Median segment less coarsely wrinkled, with three shortened longitudinal wrinkles. Metapleura intricately wrinkled. Wings yellowish. Claw with one large tooth, almost furcate. Otherwise, like the preceding species.

Length, 6.5 millimeters.

LUZON, Tayabas, Mount Banahao.

Cleistepyris philippinensis Kieff.

LUZON, Laguna, Los Baños, Mount Maquiling, Pagsanhan: Tayabas, Mount Banahao.

Cleistepyris consobrinus sp. nov.

Male.—Black. Mandible, distal end of scape, and second antennal segment red-brown; palpi pale; flagellum black-brown; tarsi and fore tibiæ testaceous.

This species is closely related to *C. philippinensis;* in both species the clypeus is only slightly keeled, broadly rounded in front; the mandible very much widened distally, coarsely wrinkled, and 4- or 5-toothed; the antenna closely white-haired; the parapsidal furrows almost parallel, somewhat widened behind and not reaching posterior margin; and the postmarginal much shorter than the pterostigma. *C. consobrinus* however is differentiated by the following markings: The head is not punctured thimblelike as in *C. philippinensis,* but has a few close punctures which do not touch each other. Antenna longer, thinner distally, third joint more than twice as long as thick, twelfth at least four times as long as thick, whereas in *C. philippinensis* it is not three times as long as thick. Pronotum, mesonotum, and scutellum smooth, with several scattered punctures. Veins of distal submedian cell very pale. Abdomen without red marking, whereas in *C. philippinensis* the posterior margin of second tergite is more or less red-brown.

Length, 6 millimeters.

LUZON, Tayabas, Mount Banahao.

Cleistepyris minimus Kieff.

Male.—In this species mandible and clypeus are shaped as in *C. consobrinus* and *C. philippinensis.* The palpi are pale, the antennæ pale yellow to brownish, becoming gradually darker distally. The postmarginal is almost twice as long as the pte-

rostigma. The legs are pale yellow to brownish, and the fore coxæ brown to black-brown.

Length, 3 to 5 millimeters.

MINDANAO, Butuan and Dapitan.

Cleistepyris minimus var. **clypeatus** var. nov.

Male.—Clypeus red-brown, mandible and palpus testaceous, antenna yellow, gradually becoming brown distally. Median segment without longitudinal carina, coarsely wrinkled. Abdomen dark red-brown.

Length, 3 millimeters.

PALAWAN, Puerto Princesa.

Cleistepyris minor Kieff.

Male.—This species is differentiated from the four preceding ones by the shape of the clypeus and of the mandible. Clypeus triangular, sharply keeled, pointedly projecting in front. Mandible narrow, almost lineal, scarcely broader, distally smooth, obliquely truncate, terminating in a single pointed tooth. Punctures on head close but not touching each other. Antennæ yolk-colored, becoming gradually brown distally, infrequently unicolored yellow.

Punctures on pronotum, mesonotum, and scutellum very scattered, usually wanting on anterior half of mesonotum; parapsidal furrows more or less shortened in front. Postmarginal wanting, or at least much shorter than pterostigma. Legs yolk-colored, fore and hind coxæ and hind femora except the distal end dark brown, infrequently all of the coxæ yellow. Claw with one tooth, as in the four preceding species.

Length, 3.5 to 5.5 millimeters.

LUZON, Laguna, Los Baños, Mount Maquiling, Paete: Tayabas, Mount Banahao, Malinao. MINDANAO, Butuan.

Genus CHLOREPYRIS Kieffer

a^1. Claw with one tooth; mandible with four teeth........ **C. unidens** sp. nov.

a^2. Claw bidentate; mandible with one tooth.

- b^1. Median segment somewhat elongate, with five contiguous longitudinal carinæ, only the median carina reaching posterior margin; pterostigma truncate distally.. **C. raripilus** sp. nov.
- b^2. Median segment somewhat transverse, with five contiguous, continuous longitudinal carinæ; pterostigma distally tapering. **C. raptor** sp. nov.

Chlorepyris raripilus sp. nov.

Male.—Black, smooth, shining. Head almost circular, scarcely longer than broad, with moderately coarse, not close punctures.

Clypeus keeled, pointedly projecting. Eye bare, elongate, twice as long as its distance from posterior margin of head, four times as long as cheek; posterior ocelli twice as far from posterior margin of head as from each other. Mandible red-yellow, long, narrow, obliquely truncate at end and terminating in a pointed, slightly curved tooth. Palpi pale, maxillary palpus reaching beyond middle of head, at least four-jointed. Antenna without hairs, scape black-brown, as long as fourth joint, the following joints reddish, gradually darkening to black-brown; second joint very small, scarcely as long as thick, thinner than the following ones; third longest, almost three times as long as thick; fourth like fifth, almost twice as long as thick; third to fifth weakly curved; the following ones cylindric, gradually becoming thinner; twelfth more than twice as long as thick, scarcely shorter than the last segment.

Pronotum almost transverse, posteriorly scarcely broader than anteriorly, with traces of scattered hairy punctures, almost twice as long as mesonotum, the latter smooth, without punctures. Parapsidal furrows terminating abruptly in front of anterior and posterior margins, converging and widening posteriorly. Scutellum smooth, bifurcate at base, the foveæ rather circular, separated from each other by almost twice their width, and connected by a fine furrow. Median segment scarcely longer than broad, marginate laterally and posteriorly, closely transversely striated, with five contiguous longitudinal carinæ in the middle, the median one continuous, the other four slightly converging posteriorly and not reaching posterior margin; posterior surface vertical, transversely aciculated, with a median longitudinal carina. Metapleura finely, longitudinally aciculated.

Wings almost hyaline. Pterostigma distally truncate, in the proximal half with a white dot, pale yellow like the veins; costal thick, contiguous to subcostal; basal very slanting, originating in the proximal end of pterostigma, half as long as radial; transversal almost vertical, shorter than basal. Tibiæ brown without spines; tarsi red-yellow; second to fourth joints of fore tarsus somewhat transverse and heart-shaped; claws furcate, proximal tooth shorter and much broader than distal, and obliquely truncate. Abdomen convex, smooth, conically tapering caudad.

Length, 5.5 millimeters.

MINDANAO, Butuan.

Chlorepyris raptor sp. nov.

Male.—Black, smooth, and shining. Head, mandible, and clypeus as in the preceding species but the eye (which is bare)

is longer by two-thirds than the occiput. Palpi pale. Antenna red-yellow except the scape, bare, and shaped as in the preceding species. Pronotum twice as long as mesonotum; this with fine, not very close punctures; parapsidal furrows continuous, almost parallel, thin, posteriorly abruptly ovately widened. Grooves of scutellum separated from one another by more than three times their diameter but connected by a fine furrow. Median segment scarcely transverse, marginate laterally and posteriorly, transversely striated, with five contiguous, continuous, almost parallel, longitudinal carinæ; posterior surface faintly excavated, rather smooth, with a median longitudinal carina. Metapleura finely, longitudinally aciculated; mesopleura smooth.

Wings yellowish; pterostigma tapering distally, a white dot in the proximal half; basal very slanting, originating in the white dot of pterostigma, half as long as radial, longer than transversal, this less oblique, curved terminally; subcostal contiguous to costal; no postmarginal. Tibiæ brown, knees and tarsi rusty yellow; middle tibia very slightly spined; third and fourth joints of fore tarsus heart-shaped, as long as broad; claws furcate, proximal tooth pointed like the distal one and a little shorter. Abdomen convex, tapering conically behind.

Length, 5.5 millimeters.

NEGROS, Cuernos Mountains.

Chlorepyris unidens sp. nov.

Female.—Black, shining. Head almost circular, with coarse, rather close punctures, the interspaces smooth, yellow pubescent, like pronotum; frons faintly notched anteriorly; clypeus very small, scarcely visible; cheek almost wanting; eye bare, somewhat shorter than occiput; posterior ocelli separated from posterior margin of head by twice their diameter. Mandible dark brown, distally very broad, with two large lower and two smaller upper dark teeth. Palpi small. Antenna red-brown; scape black, broader than flagellum, curved, as long as the following three joints together, coarsely punctured and yellow pubescent like the head, second and third joints somewhat thinner than the following ones, scarcely as long as thick, smooth and shining; fourth to thirteenth at first as long as thick, then somewhat longer; hairs recumbent, scarcely visible.

Pronotum somewhat longer than broad, gradually broader caudad, coarsely punctured like the head. Mesonotum two-thirds as long as pronotum, anterior half smooth, posterior half

rather coarsely punctured; parapsidal furrows diverging in the anterior half, parallel and scarcely broader in the posterior half. Scutellum with coarse punctures laterally, the two foveæ widely separated from each other, nearer to the lateral margin of scutellum, connected by a fine cross furrow. Median segment almost quadrate, marginate laterally and posteriorly, cross-wrinkled, with five contiguous, continuous, parallel longitudinal carinæ; posterior surface smooth, with a medial longitudinal carina. Metapleura opaque, very finely longitudinally striated, mesopleura scatteredly punctured.

Wings yellowish; subcostal contiguous to costal, pterostigma three times as long as wide, rounded distally, yellow like the veins, white at base; postmarginal wanting; basal very oblique, somewhat curved, originating in the distal end of subcostal; transversal as long and as oblique as basal, not curved, but the posterior end incurved; radial twice as long as basal. Tegula red-brown; fore tibia dark red-brown; all tarsi rusty red; femora, especially the fore, compressed and very much broadened laterally, more than twice as broad as the thickened tibiæ; middle tibia strongly spined, second to fourth joints of fore tarsus heart-shaped, nearly transverse, spined; claw with one small tooth in the middle. Abdomen convex, with hairy spots on the conical posterior half.

Length, 7 millimeters.

LUZON, Tayabas, Mount Banahao.

Genus CALYOZA Westwood

Calyoza nigra sp. nov.

Male.—Black, smooth, shining. Head with moderately close and slightly coarse punctures, as long as broad; eye bare, elongate, three times as long as cheek, twice as long as its distance from posterior margin of head; posterior ocelli scarcely farther from posterior margin of head than from each other; mandible sublinear, distal end truncate and toothed, the lower tooth moderately long, the two or three upper ones scarcely visible; maxillary palpus half as long as head, at least 4-jointed; labial palpus at least 2-jointed; clypeus not visible. Antenna 13-jointed, the first three joints black, the others black-brown; scape at least twice as long as thick, second and third joints hardly visible, forming small, shining, very transverse rings; fourth to eleventh thick, nearly transverse when viewed from above; twelfth longer than thick, thirteenth twice as long as twelfth, fourth to twelfth ventrally with a straplike, compressed, very short-pubescent

branch, first and last branches not twice as long as joint, the seven remaining two to three times as long as the joint.

Pronotum somewhat longer than broad, broadening caudad, punctured like the head; mesonotum strongly transverse, scarcely longer than scutellum, both punctured like the head; parapsidal furrows strongly widened behind, lateral furrows almost continuous. Grooves of scutellum separated from each other by more than their breadth. Median segment dorsally flat, coarsely cross-grooved, laterally and posteriorly edged by a groove; this is bordered on both sides by a carina; middle part of segment with a median longitudinal carina and two lateral oblique carinæ, these converging posteriorly; posterior surface vertical, transversely striated, with a median longitudinal carina. Metapleura closely longitudinally striated; mesopleura coarsely punctured.

Wings yellow, shining; pterostigma large, golden yellow like the veins; pubescence yellow, very fine and short; radial scarcely longer than basal; subcostal near to anterior margin; basal very slanting, originating in the distal end of subcostal, much longer than transversal, this almost vertical; medial not passing beyond the basal cell. Tarsi and distal end of fore tibia rust colored, middle tibia with very small, yellow, scarcely visible spines; joints of fore tarsus elongate; claw curved, furcate, proximal tooth somewhat shorter than the distal one, base of claw with a blunt projection. Abdomen strongly convex, gradually tapering to a point.

Length, 4.5 to 8 millimeters.

PALAWAN, Puerto Princesa.

Genus **APENESIA** Westwood

Hitherto no species of this genus has been known from the Philippines. Professor Baker has sent me the following:

Apenesia unicolor Kieff.

Female.—Eyes only punctiform.

PALAWAN, Puerto Princesa.

This species has hitherto been known only from Fernando Po Island, West Africa.

Genus **PSEUDISOBRACHIUM** Kieffer

Pseudisobrachium philippinarum sp. nov.

Female.—Black, opaque, without wings. Head quadrangular, scarcely longer than broad, broader than pronotum by a half,

with fine yellow hairs, dorsally and ventrally rather flat, reticulate-punctate, the posterior half dorsally with a smooth median longitudinal line; eyes and ocelli wanting; mandible yellow, two-thirds as long as head, narrow, bidentate at end, the two teeth brown and narrow. Palpi yellow, small; maxillary palpus with three prominent joints. Antenna yellow, 13-jointed; scape curved, as long as the following five joints together, third to thirteenth joints compact, twice as thick as long, only the third and the thirteenth elongate. Thorax shaped as in *P. intermedium* Kieff.[2]

Pronotum with a narrow red crossband before the posterior margin, coarsely and closely punctured like the mesonotum. Median segment shining, almost smooth, very finely coriaceous. Legs yellow, middle tibia closely spined laterally. Abdomen shining.

Length, 4 millimeters.

MINDANAO, Butuan.

This is the first species of this genus from the Indo-Malayan region.

Pseudisobrachium unidens sp. nov.

Male.—Black. Head short-elliptic, somewhat longer than broad, lustrous, closely and moderately coarsely punctured; eye hairy, separated by almost its entire length from posterior margin of head; posterior ocelli as far from each other as from posterior margin of head. Clypeus yellow in front, large, very transverse, medial projecting in front sharply triangularly, faintly keeled. Mandible yellow, rather long, narrow, distally scarcely broader, terminating in a sharp tooth. Palpi pale; maxillary palpus at least 4-jointed. Antenna almost imperceptibly pubescent, first and second joints yellow, first as long as third, second annular and very small, third scarcely longer than fourth, this fully twice as long as thick, distal joints thinner, twelfth much shorter than the last one.

Pronotum, mesonotum, and scutellum opaque and finely coriaceous; pronotum also with rather close, shallow punctures, scarcely as long as broad, broader behind than in front, somewhat longer than mesonotum; parapsidal furrows wanting; scutellum with a straight cross furrow in front; median segment distinctly longer than broad, coriaceous, shining, with one continuous median longitudinal carina, marginate laterally but not

[2] Tierreich 41 (1914) 472, fig. 176.

so posteriorly, posterior declivous surface without longitudinal carina. Mesopleura and metapleura finely coriaceous.

Wings brownish, with white, branched lines; subcostal contiguous to costal, distally less so; pterostigma narrow, with white proximal end; postmarginal half as long as radial; basal oblique, separated by its length from the white base of pterostigma; radial almost four times as long as basal; transversal sending forth a longitudinal vein behind the middle; only traces of distal and posterior veins of discoidal cell present; tegula yellow. Legs very pale yellow; femora slightly thickened. Abdomen almost flat, elongate-elliptic.

Length, 3 millimeters.

LUZON, Laguna, Mount Maquiling.

Genus PAREPYRIS Kieffer

No species of this genus has hitherto been known from the Philippines.

a^1. Claws straight, the two proximal teeth much broader than the distal ones, truncate at the end; wings brownish, with white lines.
P. truncatidens sp. nov.

a^2. Claws curved, the two proximal teeth pointed, not broader than the distal ones.

- b^1. Wings hyaline, without white lines; metapleura opaque, very finely longitudinally striate .... P. acutidens sp. nov.
- b^2. Wings brownish, with white branched lines; metapleura smooth and shining .... P. pleuralis sp. nov.

Parepyris truncatidens sp. nov.

Male.—Black, shining. Head almost circular, scarcely longer than broad, finely and not closely punctured; forehead blunt in front; clypeus strongly keeled; eyes bare, elongate, distance between them two-thirds longer than their distance from posterior margin of head; posterior ocelli separated from posterior margin by twice their diameter; cheeks almost wanting; mandible red-brown, curved, sublineal, distally truncate, the lower edge terminating in a sharp tooth. Palpi pale; maxillary palpus almost reaching posterior margin of head, at least 4-jointed; ultimate joint of labial palpus twice as long as penultimate. Antenna brown, filiform, scape black-brown, as long as the following two joints together; second joint somewhat shorter than third, cylindric as are the following, fourth scarcely longer than third, fourth to twelfth twice as long as thick, thirteenth longer than twelfth; hairs erect, half as long as thickness of joints.

Pronotum smooth, narrower than head, at least as long as broad, broader behind than in front; mesonotum strongly trans-

verse, smooth, much shorter than pronotum; parapsidal furrows parallel, gradually widening behind, scarcely terminating in front of the posterior margin; scutellum smooth, grooves oval, separated from each other by their diameter. Median segment scarcely transverse, marginate laterally and posteriorly, smooth, shining, with a continuous median longitudinal carina and two lateral parallel carinæ reaching only to the middle, the space between these carinæ irregularly, longitudinally rugose to the posterior margin; posterior angles truncate; posterior surface vertical, smooth, shining, with a median longitudinal carina. Metapleura opaque and finely coriaceous; mesopleura almost smooth, shining.

Wings brownish, with white, branched lines; subcostal almost touching costal; pterostigma narrow and long, proximal white, postmarginal half as long as radial, this curved, two and a half times as long as basal; transversal curved; basal very slanting, originating in the thickened distal end of subcostal; tegula red-brown. Femora black-brown; tibiæ brown, their distal end and the tarsi rusty red, second to fourth joints of fore tarsus heart-shaped, almost transverse; claw straight, pectinate, tridentate, its distal tooth curved and pointed, the two proximal ones much broader but somewhat shorter than the distal, broadly truncate at end. Abdomen slightly convex, smooth, somewhat tapering behind.

Length, 3.8 millimeters.

MINDANAO, Butuan. NEGROS, Cuernos Mountains.

Parepyris acutidens sp. nov.

Male.—Black. Mandible and tegula red-brown; palpi pale, scape and the next following joints testaceous, the other joints gradually becoming dark brown; femora black-brown, tibiæ light brown, tarsi rusty yellow. Differentiated from the preceding species by the following characters: Hairs of antenna scarcely visible, not one-third as long as the thickness of joints; pronotum somewhat transverse, much longer than mesonotum; parapsidal furrows distinctly diverging anteriorly. Median segment finely wrinkled, between the three longitudinal carinæ with coarser and almost reticulate wrinkles; metapleura opaque, very finely striate longitudinally. Wings hyaline, without white lines; postmarginal distinctly reaching beyond the middle of radial. Claws curved, the three teeth pointed, equally broad

Length, 5.6 millimeters.

MINDANAO, Butuan.

Parepyris pleuralis sp. nov.

Male.—Black. Mandible and tegula red-brown; palpi pale, scape black-brown proximally, testaceous distally, the three or four following joints testaceous, the following ones gradually growing darker to black-brown; femora black-brown, tibiæ brown, tarsi rusty yellow. Differentiated from *P. acutidens* by the following characters: Hairs of antenna one-third as long as thickness of joints; parapsidal furrows scarcely diverging; metapleura smooth and shining; wings brownish, with white, branched lines, simulating the obsolete veins. Teeth of claw pointed and shaped as in the preceding species.

Length, 4 millimeters.

LEYTE, Tacloban.

Genus **MELANEPYRIS** Kieffer

Only an African species has been known hitherto in this genus.

Melanepyris asiaticus sp. nov.

Male.—Black, shining. Head and thorax finely hairy; head distinctly longer than broad, with fine, scattered punctures; eye bare, elongate, almost as long as its distance from posterior margin of head; forehead truncate in front; cheek almost wanting; clypeus strongly keeled. Mandible red-brown, sublineal, distally truncate, lower edge terminating in a sharp tooth, the two upper teeth very small. Antenna dark brown, filiform, distally thinner, distal end of first two joints light brown; scape little shorter than the following two joints together; second joint almost twice as long as thick, shorter than third; fourth scarcely longer than third, more than twice as long as thick; twelfth more than three times as long as thick, scarcely shorter than thirteenth; hairs half as long as thickness of joints. Palpi pale; maxillary palpus reaching beyond middle of head, at least 4-jointed, labial palpus at least 2-jointed.

Pronotum trapezoid, as long as broad, punctured like the head, at least a third longer than mesonotum; this smooth in the anterior half, in the posterior half finely coriaceous and punctured like the pronotum; parapsidal furrows parallel, fine, ovately widened at posterior end. Scutellum opaque, coriaceous, finely punctured, grooves elliptic, separated from each other by a carina. Median segment somewhat elongate, marginate laterally, not so posteriorly, finely coriaceous or finely transversely striate, with a continuous medial longitudinal carina; posterior surface smooth, somewhat depressed, with a

median carina; metapleura opaque, finely rugose longitudinally; tegula red-brown.

Wing lightly brownish; subcostal adjacent to costal; pterostigma narrow, long, the second quarter white; radial curved, two and one-half times as long as basal; postmarginal a third as long as radial; basal very oblique, originating in the proximal end of pterostigma, somewhat more oblique than the curved transversal. Legs light brown, coxæ black, femora thick, tibiæ without spines, claws simple. Abdomen rather flat, smooth, long-elliptic.

Length, 4.8 millimeters.

MINDANAO, Dapitan.

Genus **HOLEPYRIS** Kieffer

a[1]. Pronotum with a fine median longitudinal furrow in the posterior half, with reticulate punctation like that on head; posterior surface of median segment with three longitudinal carinæ.... **H. dubiosus sp. nov.**

a[2]. Pronotum without longitudinal furrow, smooth, almost without punctation as the head... **H. philippinensis sp. nov.**

Holepyris philippinensis sp. nov.

Male.—Black. Head almost quadrate, smooth, shining, with few, scattered, small punctures; eye subglabrous, very short and very sparsely hairy, much longer than occiput; posterior ocelli separated from posterior margin of head by their diameter; clypeus very transverse, trilobed, the median lobe triangular and strongly keeled; mandibles red; palpi pale, maxillary palpus 5-jointed. Antenna dark red-brown, distal end of scape and second joint lighter, scape distinctly shorter than second and third joints together, second joint twice as long as thick, third scarcely longer than second, fourth somewhat shorter than third, the next following ones like the fourth, distal joints gradually shorter, twelfth scarcely twice as long as thick, shorter than thirteenth, the hairs not half as long as the thickness of joints.

Pronotum smooth and shining, like the mesonotum and scutellum, trapezoid and transverse, anteriorly with an impressed crossline; mesonotum somewhat shorter than pronotum; cross furrow of scutellum broad; median segment at least as long as broad, laterally and indistinctly posteriorly marginate, finely wrinkled, with five longitudinal carinæ in the middle, the medial carina continuous, the other four not so, posterior surface vertical, finely wrinkled, with three longitudinal wrinkles in the middle. Metapleura shining, very finely coriaceous, mesopleura coarsely so.

Wings brownish, with white branched lines; pterostigma narrow, brown like the veins, proximal third white; postmarginal wanting; basal very oblique, arising a little before the distal end of subcostal; radial more than three times as long as basal; transversal as long and as oblique as basal. Femora black-brown, trochanters, tibiæ, and tarsi testaceous, tibiæ without spines, claws furcate, both teeth pointed and of equal length, at base a blunt projection. Abdomen slightly convex, long-elliptic.

Length, 3.2 millimeters.

MINDANAO, Butuan.

Holepyris philippinensis var. **fuscicornis** var. nov.

Male.—Like the preceding, with the following exceptions: Antenna black-brown, first and second joints testaceous; head very finely coriaceous, with scattered fine punctures; eye not so long, only one-third longer than occiput. Median segment with three longitudinal carinæ; posterior surface with a median carina.

Length, 3.5 millimeters.

MINDANAO, Butuan.

Holepyris philippinensis var. **rugosus** var. nov.

Male.—Like the type, with the following exceptions: Mandible long, thin, pointed, and much curved. Posterior surface of median segment without carina, with coarse, almost reticulate wrinkles like the mesopleura and the metapleura. Legs brownish yellow, coxæ black, fore and hind femora brown in the middle.

Length, 3.5 millimeters.

LUZON, Mount Maquiling.

Holepyris dubiosus sp. nov.

Female.—Black, only the trochanters and tarsi dark red-brown. Head opaque, somewhat longer than broad, behind the eyes rather narrowed, reticulate-punctate. Eye shortly hairy, at least twice as long as occiput. Posterior ocelli nearer to posterior margin of head than to each other; cheek almost wanting; maxillary palpus at least 4-jointed; scape somewhat longer than second and third joints together; joints two to twelve cylindrical, the second one-half longer than thick, third twice as long as thick, the following ones slightly shorter than third, all elongate, thirteenth long and tapering to a point.

Pronotum opaque, reticulate-punctate, distinctly longer than broad, somewhat broader behind than in front, much narrower

than head, the posterior half with a fine median furrow, a cross-row of small depressions in front of posterior margin. Mesonotum transverse-elliptic, half as long as pronotum, lustrous and rather smooth, anteriorly with a smooth, depressed, curved crossline, posteriorly with a curved, coarse, crenulated cross furrow; scutellum with a broad cross furrow. Median segment as broad as long, laterally and posteriorly marginate, cross-wrinkled, with five parallel, continuous longitudinal carinæ in the middle, posterior angles truncate and with two small teeth; posterior surface vertical, coarsely rugose, with three continuous, contiguous longitudinal carinæ. Metapleura closely and coarsely longitudinally striated, the striæ sometimes curved and concentric; mesopleura opaque, coarsely rugose; propleura opaque and coriaceous.

Wings brownish, with white, branched lines; pterostigma narrow, brown like the veins, proximal third white; subcostal near to costal; postmarginal wanting; basal much oblique, arising in the distal end of subcostal; radial two and a half times as long as basal; transversal as oblique as basal. Legs almost bare; femora moderately thick; third and fourth joints of fore tarsus deep heart-shaped. Abdomen convex, smooth, consisting of seven or eight segments tapering to a point behind and with a projecting ovipositor.

Length, 4.5 millimeters.

PALAWAN, Puerto Princesa.

Genus **XENEPYRIS** Kieffer

Xenepyris exaratus sp. nov.

Male.—Like *X. compressicornis* but distinguishable from it by the following characters: Black; mandible red-brown; palpus and antenna yellow; scape brown; legs brownish yellow, fore coxæ darker; eye twice as long as occiput; antenna not distinctly compressed, joints three to eleven fully twice as long as thick, twelfth longer than the one preceding; parapsidal furrows dorsally scarcely widened and strongly converging; grooves of scutellum scarcely separated from each other by their breadth; median segment with three longitudinal carinæ, the middle one continuous, the other two scarcely extending beyond the middle; dorsal vertical surface transversely striate; metapleura coarsely longitudinally striated; basal almost twice as long as transversal.

Length, 4 millimeters.

LUZON, Laguna, Mount Maquiling.

Genus **RHABDEPYRIS** Kieffer

a^1. Postmarginal wanting; eye one-third longer than occiput.
R. defectus sp. nov.

a^2. Postmarginal longer than basal; eye more than twice as long as occiput.
R. luzonicus Kieff.

Rhabdepyris defectus sp. nov.

Female.—Black. Head almost circular, opaque, with almost thimblelike punctation and, like the dorsum of thorax, finely yellow pubescent. Eye a third longer than occiput with close yellow hairs; posterior ocelli scarcely farther from posterior margin of head than each other. Clypeus triangular, strongly keeled. Mandible red-brown, sublinear, quadridentate, the two upper teeth very small, the two longer ones moderately long. Palpi pale. Antenna dark red-brown, ventrally lighter red; greater part of scape black-brown, as long as the following three joints combined, second joint turbinate, somewhat elongate, scarcely longer and thinner than third, this as long as thick, joints four to twelve transverse, thirteenth elongate and pointed, all glabrous.

Pronotum scarcely elongate, opaque, very finely coriaceous and with close, moderately coarse, very shallow punctures, somewhat broader behind than in front, mesonotum two-thirds as long as pronotum, shining, anterior half unpunctured, posterior half closely and finely punctured; parapsidal furrows parallel, the lateral furrows almost continuous; scutellum sculptured like pronotum, cross furrow broad. Median segment as long as broad, wrinkled crosswise, with five contiguous, parallel, and continuous longitudinal carinæ in the middle, laterally and posteriorly marginate; posterior angles truncate, with two indistinct teeth; posterior declivous surface somewhat excavated, almost smooth, the edges coarsely wrinkled, with one broad median carina. Metapleura obliquely striate; mesopleura coarsely coriaceous.

Wings slightly yellowish; pterostigma and veins yellow; marginal wanting; basal oblique, arising in the distal end of subcostal; transversal less oblique; radial three times as long as basal; white lines branched. Femora dark brown, the four fore tibiæ red-brown like the tarsi; tibiæ without spines; third and fourth joints of fore tarsus heart-shaped. Abdomen convex, tapering to a point behind.

Length, 5 millimeters.

LUZON, Laguna, Mount Maquiling.

Rhabdepyris luzonicus Kieff.

Male.—Posterior ocelli separated from each other and from the posterior margin of head by their diameter. Flagellum very short pubescent. Posterior surface of median segment as in the preceding species. Metapleura coarsely wrinkled.

LUZON, Laguna, Mount Maquiling.

Genus **EPYRIS** Westwood

In addition to the two species already known from the Philippines, there are sixteen new species.

*a*¹. Median segment with one longitudinal carina in the middle; grooves of scutellum separated from one another by at least their width.
  *b*¹. Postmarginal wanting .... **E. parvidens** sp. nov.
  *b*². Postmarginal well developed .... **E. unicarina** sp. nov.
*a*². Median segment with three longitudinal carinæ in the middle.
  *c*¹. Pronotum with an impressed crossline in front and behind. **E. quaesitor** sp. nov.
  *c*². Pronotum without impressed crossline.
    *d*¹. Eye glabrous; third antennal joint of male longer than fourth, second thinner than third.
      *e*¹. Metapleura coarsely longitudinally striate; pterostigma and radial black-brown .... **E. psilomma** sp. nov.
      *e*². Metapleura finely coriaceous; pterostigma and all veins golden yellow .... **E. quadratus** sp. nov.
    *d*². Eye hairy.
      *f*¹. Grooves of scutellum separated from one another by at least their breadth.
        *g*¹. Costal wanting; grooves of scutellum separated by twice their breadth .... **E. apertus** Kieff.
        *g*². Costal present.
          *h*¹. Head almost twice as long as broad; eye shorter than occiput; veins and pterostigma yellow .... **E. magniceps** sp. nov.
          *h*². Head almost circular; eye at least as long as occiput.
            *i*¹. Eye more than twice as long as occiput; grooves of scutellum separated by their diameter; veins and pterostigma yellow .... **E. pusillus** sp. nov.
            *i*². Eye as long as occiput or scarcely longer, grooves of scutellum separated by three times their diameter; pterostigma black-brown, veins pale .... **E. distans** sp. nov.
      *f*². Grooves of scutellum in contact or separated only by a carina.
        *j*¹. Transversal branching off before the middle in a short branch .... **E. subramosus** sp. nov.
        *j*². Transversal without branch.
          *k*¹. Eye distinctly longer than occiput (that is, than distance of eye from posterior margin of head).

l^1. Postmarginal well developed; wing hyaline.
m^1. Legs yellow, middle of femora brown; pterostigma and veins brown; pronotum and mesonotum opaque, finely coriaceous, unpunctured. **E. claripennis** sp. nov.
m^2. Legs black, tibiæ and tarsi red; pterostigma and veins yellow; pronotum coriaceous and closely punctured; mesonotum smooth and shining. **E. despectus** sp. nov.
l^2. Postmarginal wanting.
n^1. Legs unicolored red-yellow; eye two-thirds longer than occiput; median segment at least as long as broad; pronotum and mesonotum smooth and shining .... **E. rejectus** sp. nov.
n^2. Legs partly black; eye not so long; median segment somewhat transverse.
o^1. Mesonotum smooth and shining in the anterior half, in the posterior coarsely and closely punctured like the pronotum; coxæ and femora black.
p^1. Mandible bidentate; wing hyaline; antenna red-brown .... **E. bidens** sp. nov.
p^2. Mandibles with three teeth .... **E. tridens** sp. nov.
o^2. Mesonotum uniformly sculptured.
q^1. Pronotum, mesonotum, and scutellum shallowly and not very coarsely punctured; grooves of scutellum separated by a carina. **E. philippinensis** Kieff.
q^2. Pronotum and mesonotum opaque, finely coriaceous, unpunctured; scutellum smooth and shining .... **E. troglodytes** sp. nov.
k^2. Eye only as long as occiput; head coarsely and closely punctured; median segment at least as long as broad; postmarginal wanting .... **E. obliquus** sp. nov.

Epyris distans sp. nov.

Female.—Black. Head rather quadrate, scarcely elongate, almost smooth, with very fine, hairy, scattered punctures, and very finely coriaceous. Eye hairy, not or scarcely longer than occiput; posterior ocelli touching posterior margin of head; clypeus triangular, strongly keeled; mandibles yellow-red, lineal, narrow, curved, obliquely truncate at the end. Palpi pale; maxillary palpus at least 4-jointed. Antenna yellow-red, glabrous; scape dark in the middle, as long as the following three joints together, second and third joints transverse, fourth as long as thick, the last three or four somewhat elongate, thirteenth longer and thinner.

Pronotum sculptured like the head, as long as broad, widened dorsally, almost twice as long as mesonotum, this smooth like scutellum; parapsidal furrows parallel, dorsally scarcely broader,

lateral furrows short; grooves of scutellum small, separated by three times their breadth. Median segment as long as broad, laterally and dorsally marginate, cross-wrinkled, with three parallel longitudinal carinæ in the middle, the medial carina continuous, the other two reaching only to the middle; posterior surface vertical, almost smooth, with one longitudinal carina. Metapleura very finely longitudinally striate.

Wings faintly fuliginous; pterostigma brown, proximal third white, veins pale; postmarginal wanting; basal very oblique, arising in distal end of subcostal; radial two and a half times as long as basal; transversal as oblique and as long as basal, angularly curved at posterior third. Tegulæ, trochanters, knees, tibiæ, and tarsi yellow-red, femora brown, middle tibia short and weakly spined; joints 2 to 4 of fore tarsus heart-shaped; claw with a very small, almost invisible tooth. Abdomen convex, gradually coming to a point behind, smooth.

Length, 4 millimeters.

LUZON, Tayabas, Mount Banahao.

Epyris obliquus sp. nov.

Female.—Black, shining. Head somewhat elongate, rather closely and coarsely punctured. Forehead in front bilobed; eye elongate, hairy, as long as its distance from posterior margin of head; posterior ocelli separated from posterior margin of head by their diameter; cheek very short. Mandible, palpi, and antenna yellow-red; scape as long as the following three joints united, second and third joints scarcely as long as thick, the following ones oblique, twelfth as long as thick, thirteenth elongate.

Pronotum gradually widened behind, elongate, more finely punctured than head, twice as long as mesonotum; parapsidal furrows much widened behind, shortened in front; mesonotum and scutellum punctured like pronotum; grooves of scutellum oblique, much longer than broad, almost coming together in front. Median segment at least as long as broad, quadrate, finely, transversely striate, with three continuous longitudinal carinæ, the lateral carina equidistant from the median carina and from the marginal carina, all three parallel, the posterior margin bordered by a transverse carina; dorsal surface vertical, transversely striate and with a medial longitudinal carina.

Wings fuliginous; subcostal contiguous to front margin; pterostigma elliptic, with a white dot at base, the distal brown portion not twice as long as broad; basal as oblique and as long as

transversal, arising in the distal end of subcostal, radical slightly curved, almost three times as long as basal; postmarginal wanting. Legs yellow-red, coxæ black, middle of femora black-brown, middle femur unicolored yellow-red; joints 2 to 4 of fore tarsus not longer than broad. Abdomen convex, tapering behind, dorsal third as well as the head more strongly pubescent than the rest of the body.

Length, 3 millimeters.

MINDANAO, Butuan.

Epyris bidens sp. nov.

Male.—Black, shining. Head subcylindrical, rather closely and moderately coarsely punctured; eye hairy, longer by one-third than its distance from posterior margin of head; posterior ocelli separated from posterior margin of head by twice their diameter; cheek very short. Mandible red-brown, thin, with two teeth at end, the lower tooth long and pointed, the upper one very small. Antenna without hair, filiform, red-brown, scape as long as the following two joints together, second joint somewhat tranverse, third scarcely as long as thick, fourth to twelfth somewhat longer than third, thirteenth twice as long as thick.

Pronotum somewhat elongate, moderately coarsely punctured, a little wider dorsad; mesonotum oblique, a little shorter than pronotum, parapsidal furrows parallel, much widened dorsally, anterior half of mesonotum smooth, posterior half closely punctured. Scutellum smooth, grooves oval, somewhat obliquely in contact in front. Median segment somewhat transverse, finely, transversely striate, with three continuous longitudinal carinæ in the middle, the two outer ones in front as far from the medial as from the marginal carinæ, strongly convergent posteriorly, posterior margin of median segment bordered by a cross carina; posterior surface same as in the preceding species.

Wings brownish, venation and pterostigma as in the preceding species; postmarginal wanting; transversal less oblique than basal. Tibiæ and tarsi red-brown, claws with a small tooth in the middle. Abdomen convex, conically tapering behind, unpunctured.

Length, 3 millimeters.

MINDANAO, Iligan.

Epyris tridens sp. nov.

Male.—Same as *E. bidens* except that the mandible has three teeth, the lower tooth long. Maxilliary palpus 5-jointed, labial

palpus 3-jointed. Parapsidal furrows wanting in front, slightly wide behind. Wings hyaline; postmarginal wanting in this species also.

Length, 3 millimeters.

LUZON, Laguna, Los Baños.

Epyris despectus sp. nov.

Male.—Black. Head subcylindrical, lustrous, finely coriaceous, closely and moderately coarsely punctured; eye hairy, almost twice as long as occiput, posterior ocelli separated from posterior margin of head by their diameter; clypeus triangular, strongly keeled; mandible yellow-red; palpi pale. Antenna scarcely perceptibly hairy, filiform, gradually narrowing distally, yellow-red except scape, second joint distinctly shorter and thinner than third, third to twelfth somewhat longer than thick, thirteenth longer.

Pronotum transverse, trapezoid, sculptured the same as the head but punctation shallower; mesonotum somewhat shorter than pronotum, smooth, shining, with a few indistinct, scattered, fine punctures, parapsidal furrows parallel, not widened behind; scutellum smooth, shining, grooves transversely oval, in contact. Median segment scarcely as long as broad, cross-wrinkled, laterally and posteriorly marginate, with three continuous longitudinal carinæ converging posteriorly.

Wings subhyaline; pterostigma lineal, yellow like the veins; postmarginal nearly half as long as radial; basal very oblique, arising in the distal end of subcostal, one-third as long as radial; transversal almost vertical, slightly curved. Tegulæ, tibiæ, and tarsi yellow-red, tibiæ unspined. Abdomen convex, gradually narrowing behind.

Length, 3.5 millimeters.

LUZON, Laguna, Mount Maquiling.

Epyris troglodytes sp. nov.

Male.—Like *E. bidens* with the following exceptions: Mandible red-brown, distally broader, obliquely truncate, with four teeth, the lower one long, the other three very small. Head finely coriaceous between punctures; posterior ocelli distant from posterior margin of head by more than twice their diameter; antenna black-brown. Pronotum, mesonotum, and scutellum finely coriaceous, opaque, with no punctures or a few, scattered, shallow ones; parapsidal furrows much widened and converging posteriorly. Grooves of scutellum elliptic, transverse, almost in contact. The two outer carinæ of median segment

scarcely converging posteriorly; postmarginal wanting as in the preceding species. Abdomen rather flat, long-elliptic.

Length, 3 millimeters.

LUZON, Laguna, Los Baños, 4 specimens.

Epyris claripennis sp. nov.

Male.—Like *E. troglodytes,* except that the parapsidal furrows are not distinctly widened posteriorly; wings hyaline; postmarginal half as long as radial; legs including coxæ yellow-red, only the thickened portion of femur brown.

Length, 3.5 millimeters.

LUZON, Laguna, Los Baños.

Epyris rejectus sp. nov.

Female.—Black, smooth, and shining. Head subcylindrical; eyes finely hairy, two-thirds longer than occiput; cheek very short. Palpus, mandible, and antenna testaceous, the latter becoming gradually darker distally, second and third joints thin, as long as thick, the following ones thicker and very transverse, thirteenth oblong. Pronotum a half longer than mesonotum, behind slightly broader than in front; parapsidal furrows continuous, nearly parallel, not broadened behind. Grooves of scutellum transverse and in contact. Median segment fully as long as broad, laterally and posteriorly marginate, finely cross-aciculate, in the middle with three contiguous longitudinal carinæ scarcely converging behind, the medial one continuous, the other two almost continuous; posterior surface vertical, finely, transversely aciculate, with a median carina. Metapleura finely, longitudinally striated.

Wings subhyaline; pterostigma long and narrow, basal very oblique, as much so and as long as transversal, one-third as long as radial, proximal arising in the white dot on pterostigma; postmarginal wanting; subcostal near to anterior margin. Legs testaceous, fore and hind femora brownish, tibiæ without spines. Abdomen convex, conically tapering behind.

Length, 2 millimeters.

LUZON, Laguna, Mount Maquiling.

Epyris pusillus sp. nov.

Female.—Black. Head subcylindrical, lustrous, with shallow, rather close punctures; eye finely hairy, elongate, more than twice as long as its distance from posterior margin of head; cheek very short; mandible testaceous; posterior ocelli distant

from posterior margin of head by their diameter. Forehead notched in front, bilobed. Clypeus deep, strongly keeled. Maxillary palpus pale, at least 4-jointed. Distal end of scape and the following two joints testaceous.

Pronotum, mesonotum, and scutellum almost opaque, unpunctured; pronotum one and a half times as long as mesonotum, somewhat transverse, slightly broader behind than in front. Parapsidal furrows almost parallel, widened behind, lateral furrows not continuous. Grooves of scutellum ovate, somewhat oblique, separated from each other by scarcely their diameter. Median segment slightly transverse, laterally and posteriorly marginate, opaque, finely cross-wrinkled, with three longitudinal carinæ in the middle, the outer ones of which scarcely converge behind and end shortly before the posterior margin; posterior surface vertical, finely cross-aciculate, with a median carina. Metapleura finely coriaceous, opaque; mesopleura more coarsely coriaceous.

Wings rather hyaline; pterostigma without white spot, truncate distally, pale yellow like the veins; subcostal near to anterior margin; basal very oblique, a third as long as radial, arising in the proximal end of pterostigma; transversal shorter, almost vertical; postmarginal wanting. Tibiæ and tarsi testaceous, the tibiæ without spines, claw with one tooth in the middle. Abdomen convex, tapering to a point behind.

Length, 3.5 millimeters.

MINDANAO, Butuan.

Epyris quaesitor sp. nov.

Male.—Black. Head almost quadrate, scarcely longer than broad, lustrous, shallowly and rather coarsely punctured, between punctures very finely coriaceous; eye elongate, weakly fine-haired, scarcely longer than its distance from posterior margin of head; cheek almost wanting. Forehead unnotched in front and not bilobed. Clypeus keeled; maxillary palpus pale, reaching beyond the middle of head, at least 4-jointed. Distal end of first three antennal joints red-brown, scape as long as second and third joints united, these not so long as thick, cylindrical like the following ones, which are almost twice as long as thick, all with erect hairs that are as long as half the thickness of the joints.

Pronotum sculptured like head, somewhat transverse, equally broad in front and behind, with an impressed, crenulate line running along the anterior and posterior margins. Mesonotum somewhat shorter than pronotum; parapsidal furrows almost

parallel, continuous, somewhat widened behind, lateral furrows not continuous. Grooves of scutellum ovate, almost in contact. Median segment transverse, laterally and posteriorly marginate, traversed in the middle by three parallel longitudinal carinæ, the outer ones of which scarcely reach beyond the middle; posterior surface vertical, very finely transversely striate, with a medial carina. Metapleura opaque, finely coriaceous.

Wings subhyaline; pterostigma pointed distally, with a white dot in the proximal half; subcostal near to anterior margin; basal very oblique, arising in the proximal end of pterostigma; transversal as oblique as basal, incurved at end; radial two and a half times as long as basal. Tegulæ, knees, tibiæ, and tarsi testaceous, tibiæ without spines; joints of fore tarsus not heart-shaped, somewhat longer than thick. Abdomen convex, smooth, shining, tapering conically behind.

Length, 4 millimeters.

LUZON, Laguna, Paete.

Epyris psilomma sp. nov.

Male.—Black. Head rather cylindrical, smooth, shining, with fine, not very close punctures; eye bare, elongate, more than twice as long as occiput (that is, as its distance from posterior margin of head); posterior ocelli as far from each other as from posterior margin of head; cheek almost wanting; clypeus very small. Mandible yellow-red, narrow, distally with three or four black teeth, the lower tooth long, the two or three upper teeth small; palpi pale. Antenna yellow-red, except the proximal two joints; scape as long as third joint; second very small, thinner than the following ones; third scarcely longer than fourth, almost twice as long as thick; fifth to twelfth like the fourth; thirteenth longer; all without distinct pubescence.

Pronotum transverse, broader behind than in front, unpunctured and scatteredly hairy like the mesonotum and the scutellum, longer by a half than mesonotum. Parapsidal furrows converging and much widened behind, separated from each other at the posterior end by only their breadth, anteriorly fine and not reaching anterior margin; lateral furrows not continuous. Grooves of scutellum circular, separated from each other by their diameter. Median segment as long as broad, bordered laterally by a broad groove and posteriorly by a carina, cross-wrinkled, with three longitudinal carinæ in the middle, the medial one continuous, the other two converging posteriorly and nearly continuous; posterior surface vertical, finely transversely

striate, with a medial carina. Metapleura coarsely, longitudinally striated; mesopleura with two or three coarse longitudinal carinæ.

Wings faintly yellowish; pterostigma broad, not three times as long as broad, elliptic, black-brown, with white proximal end; postmarginal wanting; radial only a half longer than basal, black-brown, the other veins golden yellow; subcostal contiguous to costal; basal very oblique, arising in the distal end of subcostal, almost twice as long as the sloping transversal. Tegulæ yellow-red; tarsi and distal end of tibiæ rusty yellow, tibiæ unspined; joints 2 to 4 of fore tarsus heart-shaped, claws with a rather large tooth. Abdomen convex, gradually narrowing behind, posterior end truncate, posterior half with close, long, black hairs.

Length, 6.5 millimeters.

PALAWAN, Puerto Princesa.

Epyris quadratus sp. nov.

Male.—Black, smooth, shining. Head nearly elliptic, somewhat longer than broad, much broader than pronotum, with indications of scattered shallow punctures. Eye bare, longer than broad, at least twice as long as its distance from posterior margin of head; posterior ocelli separated from each other by their diameter, more than twice as far from posterior margin of head as from each other; cheek almost wanting. Antenna yellow-red, scape black, second joint very small and thinner than those following, third almost three times as long as thick, the following ones almost twice, the last three thinner, darker, more than twice as long as thick; without distinct pubescence.

Pronotum scarcely transverse, posteriorly a little broader, a half longer than mesonotum; parapsidal furrows continuous, posteriorly much widened and strongly convergent, lateral furrows not continuous. Grooves of scutellum ovate, separated from each other by twice their breadth. Median segment subquadrate, scarcely transverse, finely cross-wrinkled, laterally and posteriorly marginate, traversed in the middle by three longitudinal carinæ, the middle one of which is continuous, the other two nearly so and slightly converging behind; posterior surface almost vertical, rather smooth, with a medial carina. Metapleura opaque, finely coriaceous.

Wing yellowish, pterostigma long-elliptic with white proximal end, yellow like the veins; subcostal contiguous to costal; basal very oblique, arising in the thickened distal end of subcostal;

transversal shorter and nearly vertical; postmarginal almost wanting, shorter than the breadth of pterostigma; radial curved, only one and a half times as long as basal. Tegulæ and tarsi testaceous. Abdomen convex, tapering conically behind.

Length, 4.8 millimeters.

MINDANAO, Butuan.

Epyris magniceps sp. nov.

Female.—Black, smooth, shining. Head almost twice as long as broad, quadrangular, with coarse and rather close punctures, very finely coriaceous between punctures. Eye hairy, elongate, only two-thirds as long as occiput; posterior ocelli three times as far from posterior margin of head as from each other; mandible red-brown, narrow, with two black teeth; clypeus strongly keeled, sharply triangular. Palpi pale, maxillary palpus reaching beyond the middle of head, at least 4-jointed, the last three joints long, the first one very short. Antenna yellow-red, scape black-brown proximally, not so long as second and third joints united, second joint obconical, smaller and much thinner than the following ones, these cylindrical, third and fourth almost transverse, the following ones as long as or somewhat longer than thick.

Pronotum elongate, broader behind, almost twice as long as mesonotum, punctured like the head; mesonotum smooth in the anterior two-thirds, coarsely punctured in the posterior third; parapsidal furrows almost parallel, much widened behind. Scutellum very finely coriaceous, punctured only behind the grooves, with a crossrow of punctures in front of posterior margin; grooves oval, oblique, separated from each other by twice their diameter. Median segment longer than broad, marginate laterally and posteriorly, cross-wrinkled, with three contiguous, parallel, longitudinal carinæ, the middle one continuous, the other two nearly so; posterior surface very finely, transversely aciculate, with a median carina. Metapleura finely, longitudinally aciculate, mesopleura coarsely punctured. Tegula yellow-red.

Wing yellowish; pterostigma yellow like the veins, lanceolate, narrow; postmarginal wanting; basal very oblique, arising in the distal end of subcostal, transversal as oblique and as long as basal; radial almost four times as long as basal. Middle tibia, distal ends of the remaining tibiæ, and tarsi yellow-red, middle tibia unspined. Joints 2 to 4 of fore tarsus heart-shaped,

claw with one very small tooth. Abdomen convex, tapering conically behind, and with a style.

Length, 7 millimeters.

PALAWAN, Puerto Princesa.

Epyris unicarina sp. nov.

Male.—Black, smooth, shining. Head nearly circular, with small, scattered punctures. Eye sparsely hairy, almost twice as long as occiput; posterior ocelli as far from each other as from posterior margin of head; clypeus triangular, strongly keeled; mandible yellow-red, almost lineal, bilobed at end, forming two teeth, between which are two very small teeth; palpi pale. Antenna with short hairs, filiform, scape and ventral side of the following two joints red-yellow, scape bare, as long as second and third joints united, segments 2 to 12 cylindrical, second and third not so thin as those following, second a little shorter than third, a half longer than thick, fourth distinctly longer than third, fully twice as long as thick, the following ones like the fourth, thirteenth somewhat longer and thinner.

Pronotum scarcely as long as broad, broader behind than in front, unpunctured. Mesonotum strongly transverse, somewhat shorter than pronotum, with few punctures; parapsidal furrows widened behind and converging, terminating before the posterior margin. Scutellum unpunctured, the grooves oval, separated from each other by their breadth. Median segment somewhat transverse, marginate laterally and posteriorly, rugose, with only one longitudinal carina in the middle; posterior surface vertical, cross-striated, with a median carina. Mesopleura smooth and shining.

Wing subhyaline, with white lines; pterostigma narrow, proximally with a white dot; postmarginal two-thirds as long as radial; basal oblique, arising in the distal end of subcostal; transversal less oblique, curved; radial two and a half times as long as basal; tegula yellow-red. Legs red-brown, coxæ black, femora brown, tibiæ unspined, third and fourth joints of fore tarsus as broad as long. Abdomen flat, elliptic.

Length, 3 millimeters.

MINDANAO, Butuan.

Epyris parvidens sp. nov.

Female.—Black, smooth, shining. Head distinctly longer than broad, with several scattered, very fine punctures; eye

scarcely hairy, flat, one-third longer than occiput; posterior ocelli almost touching posterior margin of head; clypeus triangular, strongly keeled; mandible red, almost lineal, truncate at end, terminating below in a sharp tooth; palpi pale, maxillary palpus at least 4-jointed. Antenna red, scape as long as the following three joints united, second joint somewhat longer than thick, third smallest, fourth to twelfth at least as long as thick, thirteenth elongate and thinner; all bare.

Pronotum distinctly elongate, broader behind than in front, twice as long as mesonotum, both unpunctured; parapsidal furrows strongly converging behind and abruptly much widened; grooves of scutellum ovate, separated from each other by twice their breadth; median segment as long as broad, marginate laterally and posteriorly, very finely transversely striate, in places obliquely striate, with a single longitudinal carina in the middle; posterior surface vertical, nearly smooth, with a medial carina. Mesopleura smooth and shining; metapleura nearly smooth.

Wings faintly brownish; pterostigma narrow, pale like the veins, proximal third white; postmarginal wanting; basal oblique, arising in the distal end of subcostal, transversal as long and as oblique as basal; radial four times as long as basal. Tegulæ and legs red, coxæ black, femora brown, fore femur black-brown, tibiæ unspined, claw with a very small, scarcely visible tooth. Abdomen convex, sharply pointed behind.

Length, 3 millimeters.

LUZON, Laguna, Mount Maquiling.

Epyris subramosus sp. nov.

Male.—Black. Head rather cylindrical, opaque, very finely coriaceous, with rather coarse and rather close punctures; eye faintly hairy, nearly twice as long as occiput; posterior ocelli separated from posterior margin of head by more than their diameter; mandible red-brown, narrow, bidentate or tridentate at end; clypeus small; palpi brown. Antenna filiform, dorsally black-brown, ventrally red-brown, scape almost as long as second and third joints united, second joint not longer than thick, third longer and thicker than second, scarcely shorter than fourth, fourth to twelfth almost twice as long as thick, thirteenth longer; without visible pubescence.

Pronotum trapezoid, somewhat transverse, sculptured like the head, little longer than mesonotum; this smooth and shining

in the anterior half, finely punctured in the posterior half; parapsidal furrows converging behind and widened. Scutellum with several scattered punctures, grooves elliptic, transverse, separated only by a carina. Median segment somewhat transverse, marginate laterally and posteriorly, cross-wrinkled, with three continuous longitudinal carinæ that converge behind; posterior surface vertical, cross-striated, with a median carina. Metapleura finely coriaceous, mesopleura closely and finely punctured.

Wings brownish, with branched white lines; pterostigma brown like the veins, proximal third white; postmarginal wanting; basal very oblique, arising in the distal end of subcostal; radial three times as long as basal; transversal oblique, curved, branching off before the middle in a very short branch. Tegulæ, tibiæ, and tarsi red-brown, middle of tibiæ brown; tibiæ unspined; joints 2 to 4 of fore tarsus heart-shaped; claw with a very small tooth. Abdomen convex, gradually narrowing behind, the pincer segments with a tuft of hair on the end.

Length, 4 millimeters.

PALAWAN, Puerto Princesa.

Genus **GONIOZUS** Förster

a^1. Head elongate........ **G. philippinensis** Ashm.
a^2. Head not longer than broad.
  b^1. Median segment rather flat, without elevation in the middle.
    c^1. Anterior section of basal as long as posterior.... **G. depressus** Kieff.
    c^2. Anterior section of basal much shorter than posterior. **G. manilensis** sp. nov.
  b^2. Median segment with a triangular elevation in the middle.
    d^1. Apex of triangular elevation connected by a longitudinal carina with posterior margin of median segment...... **G. triangulifer** Kieff.
    d^2. Triangular elevation longer, not connected by a longitudinal carina with posterior margin of median segment.... **G. triangulus** sp. nov.

Goniozus manilensis sp. nov.

Male.—Black, smooth, shining. Antennæ, mandibles, tibiæ, and tarsi yellow. Median segment bordered laterally by a fine carina, scarcely visibly marginate posteriorly, rather flat, without elevation in the middle. Wing subhyaline, prostigma and pterostigma brown, radial yellow, the other veins very pale; branch of basal much nearer to subcostal than to medial. Otherwise like *G. depressus*.

Length, 2.5 millimeters.

LUZON, Laguna, Los Baños.

Goniozus triangulus sp. nov.

Female.—Black. Mandibles, antennæ, trochanters, knees, tibiæ, and tarsi yellow, femora brown. Clypeus pointed in front, strongly keeled, the keel continued on forehead. Mandible lineal, with short teeth on the end. Joints of flagellum almost globular, distally gradually becoming thinner. Head nearly transverse, smooth and shining, like pronotum, mesonotum, and scutellum; eye three times as long as occiput. Posterior ocelli touching posterior margin of head.

Scutellum with a puncture in each anterior angle; median segment with an inverted-triangular, raised area, and shaped as in *G. triangulifer*, although in this species the raised area is much longer, reaching almost to the posterior margin of median segment and not connecting with the latter by a longitudinal carina. Wings rather hyaline, prostigma and pterostigma brown, veins pale. Abdomen behind with a style from which projects the ovipositor.

Length, 3.5 millimeters.

LUZON, Laguna, Mount Maquiling.

SCELIONIDÆ

The new species belonging to this family have been described.[3] The list follows:

SCELIONINÆ

1. ***Heptascelio lugens*** **g. et sp. nov., female. LUZON, Mount Maquiling.**
2. ***Scelio cellularis*** **sp. nov., male. LUZON, Mount Maquiling.**
3. *Scelio variipennis* sp. nov., male and female. MINDANAO, Dapitan. LUZON, Los Baños.
4. ***Scelio facialis*** **sp. nov., male. MINDANAO, Iligan.**
5. *Scelio xanthopus* sp. nov., female. LUZON, Mount Maquiling.
6. *Scelio microcerus* sp. nov., male. NEGROS, Cuernos Mountains.
7. ***Scelio macrotomus*** sp. nov., male. PALAWAN, Puerto Princesa.
8. *Sparasion parcepunctatus* sp. nov., female. LEYTE, Tacloban.
9. *Phaenoteleia rufa* g. et sp. nov., female. MINDANAO, Butuan.
10. *Camptoteleia bifurcata* sp. nov., male and female. MINDANAO, Butuan.
11. *Camptoteleia marginalis* sp. nov., male. PALAWAN, Puerto Princesa.
12. *Camptoteleia dorsalis* sp. nov., male. MINDANAO, Butuan.
13. *Camptoteleia consobrina* sp. nov., female. MINDANAO, Butuan.
14. *Camptoteleia crassicornis* sp. nov., male. LUZON, Mount Maquiling.
15. *Camptoteleia brevinervis* sp. nov., male. MINDANAO, Butuan.
16. *Camptoteleia frontalis* sp. nov., male. MINDANAO, Butuan.
17. *Camptoteleia spinosiceps* sp. nov., female. LUZON, Mount Maquiling. Possibly a new genus.
18. *Trichanteris acutiventris* sp. nov., female. LUZON, Mount Maquiling.

[3] Broteria 14 (1916) fasc. I, III; 15 (1917) fasc. I.

19. *Psilanteris atriclava* sp. nov., female. LUZON, Mount Maquiling.
20. *Dilapitha variipennis* sp. nov., male. MINDANAO, Butuan.
21. *Chrestoteleia scapularis* sp. nov., female. MINDANAO, Butuan.
22. *Chrestoteleia impressa* sp. nov., male and female. LUZON, Mount Maquiling and Pagsanhan. PALAWAN, Puerto Princesa.
23. *Phaedroteleia armata* g. et sp. nov., male. LUZON, Mount Maquiling.
24. *Phaedroteleia ruficoxa* sp. nov., male. MINDANAO, Butuan.
25. *Styloteleia rufescens* g. et sp. nov., male and female. LUZON, Mount Maquiling.
26. *Plagioscelio rufescens* g. et sp. nov., male. MINDANAO, Butuan.
27. *Plagioscelio fuscus* sp. nov., male. MINDANAO, Butuan.
28. *Tomoteleia trifasciata* g. et sp. nov., male. LUZON, Mount Maquiling.
29. *Mesoteleia pallida* g. et sp. nov., female. LUZON, Mount Maquiling.
30. *Trissoscelio nigriceps* g. et sp. nov., female. LUZON, Mount Maquiling.
31. *Trissoscelio ruficeps* sp. nov., female. LUZON, Mount Maquiling.
32. *Trissoscelio punctaticeps* sp. nov., male. LUZON, Los Baños.
33. *Macroteleia lambertoni* sp. nov., female. LUZON, Mount Banahao.
34. *Macroteleia liebeli* sp. nov., male. LUZON, Mount Banahao.
35. *Macroteleia antennalis* sp. nov., male. PALAWAN, Puerto Princesa.
36. *Macroteleia punctatifrons* sp. nov., male and female. LUZON, Mount Banahao, Malinao, Tayabas, Los Baños. NEGROS, Cuernos Mountains.
37. *Alloteleia appendiculata* g. et sp. nov., male. LUZON, Los Baños.

TELEASINÆ

38. *Trimorus luzonicus* sp. nov., male. LUZON, Mount Maquiling.
39. *Hoplogryon (Allogryon) luzonicus* sp. nov., male. LUZON, Mount Maquiling.

PLATYGASTERINÆ

40. *Sacespalus rugosiceps* g. et sp. nov. LUZON, Mount Maquiling.

IDENTIFICATION OF AMBERGRIS

By Howard Irving Cole

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Ambergris, a biliary concretion from the intestines of the spermaceti whale (*Physetes macrocephales*), is found sometimes in the mammal itself but more often floating upon the sea or in the sand on the seacoast. It occurs in lumps varying from a few ounces to 200 pounds. The substance is of a solid waxy nature, mottled dull gray to black, and possesses a peculiar earthy odor. It adheres like wax to the edge of a knife with which it is scraped, retains the impression of the nails, and emits a fat, odoriferous liquid on being penetrated with a hot needle. The specific gravity of ambergris varies from 0.780 to 0.926. It is said to melt at 62° C. It is soluble in ether and in the volatile and fixed oils.

The composition of ambergris was investigated by Pelletier and Caventou in 1820. They found that the principal constituent was a substance to which they gave the name ambraine or ambrein. The analytical values of ambrein were not published by Pelletier until 1832 when they were given as follows: Carbon, 81.74 per cent; hydrogen, 13.32 per cent; oxygen, 4.94 per cent.

In 1912 Joseph Riban [1] investigated ambrein more closely. He had come into possession of a small quantity of ambrein which in the course of time had separated out from the alcoholic liquid in a bottle intended for extract of ambergris. The substance, after being recrystallized from alcohol, melted at between 82° and 86° C. It is a white crystalline solid separating from its alcoholic solution in slender needles. Combustion showed it to possess the formula $C_{23}H_{40}O$. The compound tends to remain in the superfused state when melted, even if sown with crystals. When warm and dry it becomes highly electrified on slight rubbing. It is not optically active, has a neutral reaction, and is insoluble in water but soluble in most organic solvents. When

[1] Compt. Rend. 154 (1912) 1729–1732; Bull. Soc. Chim. IV 11 (1912) 754–757.

acted on by bromine in carbon tetrachloride solution it gives an octobromo-derivative $C_{28}H_{32}OBr_8$, a white vitreous solid. Chlorine under similar conditions decomposes it. On warming ambrein with phosphorus pentachloride, a white amorphous mass of pentachloro ambrein $C_{23}H_{35}OCl_5$ is obtained.

The physical constants of ambergris as given in the literature vary widely. No chemical methods for its identification could be found in the literature available. The Chinese test its purity by scraping it upon boiling tea in which it should dissolve.

SUPPOSED AMBERGRIS

A number of substances suspected of being ambergris have been submitted to the Bureau of Science for identification, but one in particular is so generally considered to be the genuine article as to deserve the name "supposed ambergris." This substance is usually found floating far out at sea in localities known to have yielded ambergris. It is picked up by fishermen and sold to the Chinese and Moros as ambergris. It has been shipped through the Custom House of Manila to Japan rated as "ambergris" and is used by the natives for medicinal purposes and by the Chinese and Moros probably as an aphrodisiac. In all physical appearances it closely resembles ambergris. It occurs in the same places, is found in the same quantities, and has approximately the same specific gravity and a similar mottled appearance. It, however, has a slightly different odor and becomes brittle on ageing, while true ambergris apparently does not. Since no methods of identifying it positively as ambergris were available the matter was referred to the Bureau of Chemistry at Washington. That bureau reported that "there are no satisfactory methods by which it is possible to identify ambergris. Perfumers are in a better position to determine the genuineness of this material than we would be by ordinary analytical methods."

It seems therefore that ambergris is determined in a manner analogous to that of a good wine; that is, it is judged by a connoisseur, one who recognizes it by general appearance, bouquet or odor, etc., from a physical rather than from a chemical or microscopical standpoint.

Samples of the substance were sent to the leading perfumers of the United States and Europe with the request that an opinion be rendered as to whether the material was true ambergris. The replies were almost unanimous against the substance being ambergris. At this point the facts were brought to the atten-

tion of the writer. It seems that ambergris often contains "the horny gills of a cuttlefish species" [2] which serves as food for the whale. A careful microscopical examination proved the absence of such horny material but led to the finding of occluded fragments of moss, leaves, and bark, so distributed as to suggest inclusion in the formation of the substance rather than foreign material gathered up after the lumps were formed. This naturally indicated a vegetable rather than an animal origin. A comparison with the samples of gums and resins at the Bureau of Forestry showed the substance to have a close physical resemblance to the latex from *Artocarpus elastica*.[3]

Some of the physical and chemical constants of this latex and of the supposed ambergris were determined. The results are listed in Table 1. The known constants of true ambergris are given for comparison.

From the data given above and the microscopical examination we are led to the conclusion that the various samples of "supposed ambergris" submitted to the Bureau of Science are neither ambergris nor of animal origin, but that they are originally derived from a tree probably closely related to *Artocarpus elastica*.

TRUE AMBERGRIS

Recently a substance found in southern Palawan, near Balabac, by a Moro, was submitted to the Bureau of Science for analysis. It proved to be true ambergris.[4] The material was of a waxy nature, brown with tiny specks of white distributed through it, and there were also embedded in it many fragments of the chitinous part of the internal shell or gladius of a cuttlefish. Other chitinous fragments, in the form of a parrot's beak, and the remains of the mandibles of the cuttlefish were also found. This chitinous material is probably identical with the "horny gills of a cuttlefish species" referred to earlier in this article. These fragments appear as thin, dark brown, opaque, finely striated pieces of chitin varying in thickness from 0.04 to 0.1 millimeter. No moss, bark, or other vegetable material was found in the sample.

The specific gravity of the ambergris was 0.834. The melting point was 65° C. The ash content was 0.21 per cent. After the

[2] Bruff, Chem. Abstr. 10 (1916) 1405.

[3] Philippine Resins, Gums, Seed Oils, and Essential Oils, Bull. P. I. Bur. Forestry No. 20 (1920) 68.

[4] This lot of ambergris weighed 47 kilograms.

TABLE 1.—*Comparison of true ambergris, "supposed ambergris," and latex from Artocarpus elastica.*

Substance.	Color.	Texture.	Odor.		Melting point.	
			Natural.	On burning.	Substance.	Ether extract.
True ambergris	Yellow-green to brownish black.	Waxy	Earthy	Odor of burning fæces.	65° C.[a]	82° to 88° C. (ambrein).
"Supposed ambergris."	Mottled gray to yellow.	Chewing-gum texture; yellow part is hard and brittle.	Mixture of odor of brown sugar and new sawdust.	Burning rubber odor	Softens at 100° C.; melts at 112° C.	Softens at 100° C.; melts at 120° C.
Latex from *Artocarpus elastica.*	Gray	Chewing-gum texture; some parts hard and brittle.	New sawdust odor	do	Softens at 100° C.; melts at 131° C.	Softens at 100° C.; melts at 118° C.

Substance.	Specific gravity.	Ether extract.		Ash.	Gutta.
		Saponification No.	Iodine No.		
					Per cent.
True ambergris	0.908 to 1.5028	17 to 35	78	Traces[b] 6 per cent.[c]	
"Supposed ambergris"	Variable; gray, over 1.000; yellow, less than 1.000	109.4 to 121.4	52.9 to 78.54	3.6 per cent	[d] 21.06
Latex from *Artocarpus elastica*	Variable; approximately 0.950	92.50	100.17	0.54 per cent	[d] 10.00

[a] Determined in the Bureau of Science. 60° C. is stated by Bruff, Chem. Abstr. **10** (1916) 1405, to be the melting point.

[b] Bruff, loc. cit.

[c] Jacob Lund, Chem. Abstr. **12** (1918) 773.

[d] Determined by method given in Allen's Commercial Organic Analysis 4th ed. **4**: 160. The sample of supposed ambergris was carefully selected to exclude all the brittle yellow substance. The only sample of *Artocarpus elastica* available had, however, become almost entirely crumbly (oxidized), so the gutta content is naturally low.

ambergris was melted, it remained as a brownish black viscous mass on cooling.

Attempts to crystallize the ambrein from alcohol were unsuccessful. No crystallizable product could be obtained upon acetylization with acetic anhydride.

The above data and especially the microscopical examination proved that this substance was true ambergris.

CONCLUSION

A careful microscopical examination of substances suspected of being ambergris will often prove to be of greater value in the identification of such substances than the ordinary physical or chemical methods.

NEW MALAYAN CIXIIDÆ (HOMOPTERA)

By F. MUIR

Of the Hawaiian Sugar Planters' Experiment Station, Honolulu

TWO PLATES

The three genera dealt with in this paper all possess a well-developed subantennal process in the shape of a keel across the gena. In this they differ from *Myndus* and allied genera. Measurements are from the apex of vertex to anus and from the apex to base of the tegmen. The types are deposited in the Hawaiian Sugar Planters' Experiment Station collection, and they bear the type numbers of that collection; the paratypes are in Prof. C. F. Baker's collection.

Genus KINNARA Distant, Plate 1, fig. 1

Pleroma MELICHAR, Hom. Fauna Ceylon (1913) 41, pl. 1, figs. 12, *a–c*, nom. praeoc.; BIERMAN, Notes Leyden Mus. **29** (1908) 154, pl. 3, fig. 3.

Kinnara DISTANT, Fauna Brit. India, Rhynchota **3** (1906) 289; **6** (1916) 59; MUIR, Proc. Haw. Ent. Soc. **2**[5] (1913) 265.

The genus *Kinnara* Distant is of interest as it combines characters of both the Cixiidæ and the Achilidæ. The claval veins are fairly thick and fork near the apex of clavus; in some species they end at the apex of the clavus, in others they join the suture a little before the apex. The tegmina are tectiform or subtectiform, the hind margins are not greatly produced beyond the clavus and do not overlap when at rest. The median ocellus is present in all the species that I have examined.

In the female the genital styles are very short and do not form a complete ovipositor, a condition found in the Achilidæ. The posterior abdominal tergites of the female are mostly membranous, flattened, and form a large wax-secreting area. The male pygofer is flattened laterally and is cixiidlike in construction. There is a lateral appendage on each side which arises near the base of the genital styles and is more or less connected with the sides of the pygofer. The ædeagus is complex, with a long, semimembranous, curled tube at the apex.

Until we have a greater knowledge of the morphology of the Cixiidæ and Achilidæ, I think it is best to place all fulgorids with

a median ocellus in the Cixiidæ. In *Kinnara* other characters indicate that family as the best locality in which to place this genus.

In considering the venation I have concluded that R touches M for a short distance (Plate 1, fig. 1). Only a study of the tracheation of the wing pad will settle this point beyond doubt.

This genus has a distinct subantennal flange and a smaller one at a right angle to it beneath the antenna.

Kinnara spectra Dist. Plate 1, fig. 2.

Kinnara spectra DISTANT, Fauna Brit. India, Rhynchota 6 (1916) 60.

One male and one female from Singapore agree with the description, which contains no mention as to sex or genitalia.

The lateral process on the male pygofer is long, subspatulate and subtruncate at apex; slightly dorsad of this process the margin is produced into a squarish process with the apex oblique. Anal segment large with rounded apex and concave on the ventral surface. The genital styles are subtriangular with the longest side forming the outer margin, which is sinuous; apex produced into two small processes, a slender, curved process and a smaller process. Ædeagus complex.

Anterior genital style of female subtriangular, width of base about half the length, apex rounded with a small notch slightly before apex; a transverse ridge across the base.

A comparison of these genitalia with those of the Indian specimens is necessary to confirm this identification.

Kinnara flavofasciata Dist. Plate 1, fig. 3.

Kinnara flavofasciata DISTANT, Fauna Brit. India, Rhynchota 6 (1916) 59.

Four males from Basilan and one female from Zamboanga, Mindanao, Philippine Islands (*Baker 13353*), I refer to this species until the genitalia of the Indian specimens have been examined.

In the male the lateral process of the pygofer is narrow, subequal in width to the apex which is rounded. The genital styles are narrow on basal two-thirds with subparallel sides, the apex is expanded, the outer corner produced into a beanlike process, the inner corner rounded.

Kinnara penangensis sp. nov. Plate 1, fig. 4.

Female.—Length, 3.5 millimeters; tegmen, 5.4. Stramineous; mesonotum slightly darker. Tegmina hyaline, slightly stramin-

eous, a faint fuscous band across from stigma to apex of clavus, veins stramineous. Wings hyaline, veins yellowish. Vertex about square; carinæ on mesonotum obsolete. Anal segment small, not reaching apex of genital styles. Anterior genital style triangular, length about one and one-half times the width of base with a small notch at apex on the inner side.

Penang Island (*Baker*), 1 female. Type No. 1032.

Kinnara nigrolineata sp. nov. Plate 1, fig. 5.

Male.—Length, 2 millimeters; tegmen, 3.5. Only three apical median veins, M_2 lacking; claval vein joining suture slightly before apex. Vertex wider than long. Lateral appendages of pygofer long, narrow, curved, and recurved, apex bluntly rounded. Genital styles small, narrow, inner margin slightly curved, outer margin slightly sinuate, apex truncate, outer angle produced into an acute point. Light stramineous; brownish along carinæ of face and clypeus. Tegmina hyaline, very slightly stramineous, veins slightly darker, a dark, fuscous mark from crossvein between M and Cu in middle of tegmen to apex of M_3; wings hyaline, basal and anal areas fuscous.

NEGROS, Cuernos Mountains (*Baker*), 1 male. Type No. 1033.

Kinnara bakeri sp. nov. Plate 1, fig. 6.

Male.—Length, 1.7 millimeters; tegmen, 3. Vertex about as long as broad. The base of Sc + R joined to the base of M for a very short distance. The lateral processes of pygofer long, narrow, slightly broadened in the middle, the apex acute. Genital styles, in lateral view, strongly curved at the base, broad on basal two-thirds and tapering to acute apex. Anal segment rounded at apex. Head, legs, and lateral portion of pronotum stramineous; mesonotum and abdomen dark brown. Tegmina dark fuscous, veins fuscous, lighter clear areas around the stigma and in the apical cells. Wings fuscous with dark veins.

Female.—Length, 1.8 millimeters; tegmen, 3.3. In color similar to the male. The anterior genital styles triangular, length about one and one-half times the width of base, a small flange along the base produced into a small rounded process on the inner corner.

Singapore (*Baker 9924*), 2 males and 1 female. Type No. 1034.

This species comes near *K. brunnea* Muir, but the color is somewhat distinct and the process at the base of the anterior styles of female is not so large.

183677——8

Kinnara marginalis sp. nov. Plate 1, fig. 7.

Male.—Length, 2 millimeters; tegmen, 3. Veins Sc, R, and M joined at their bases into a very short stalk. Costal cell broad, the margin all around broad, more especially along the costa. Vertex slightly wider than long. The lateral processes of pygofer narrow, long, and slightly curved. The genital styles curved, nearly straight on inner margin, outer margin concave in middle, apex rounded. Anal segment large, rounded at apex. Head, thorax, and legs stramineous or light brown, the posterior part of the mesothorax and the carinæ darker, abdomen brown. Tegmina and wings hyaline, uniformly light brown, veins darker.

BORNEO, Sandakan (*Baker 9923*), 1 male. Type No. 1035.

I have three females from Dapitan, Mindanao (*Baker*); although these are similar to *K. bakeri*, I feel sure that they will prove to be distinct when the male is known.

Genus EURYPHLEPSIA novum

Type, *E. amboinensis* sp. nov.

Tegmina comparatively narrow, subparallel-sided or slightly widened toward apex which is rounded. Margins with distinct border all around, widening out at stigma; costal cell large, Sc and R joined together to near stigma with their bases joined to M to about middle of clavus, the common base and the Sc + R thickened and joined to the stigma; forking of Cu slightly before apex of clavus. Two apical Rs, five apical Ms with the M_1 arising from M_2 in some specimens. Claval vein joining margin before apex, forking about middle, first claval vein thickened at base (Plate 1, fig. 8).

Vertex longer than wide, widest at base, which is slightly and roundly emarginate, lateral carinæ well developed, continuing unbroken on to the face, median frontal carina projecting at apex, a transverse carina about middle. Base of face about half the width of apex, apical half roundly ampliate at sides, median carina distinct to median ocellus. A distinct subantennal process across gena touching the lateral carina of face a little before apex. Clypeus large, sides flattened, lateral and median carinæ distinct. In profile median portion of face slightly protruding near apex. Antennæ short, first segment very short, second segment shorter than broad, in apical view broader than deep (Plate 2, fig. 1). Eyes slightly emarginate along ventroanterior margin. Prothorax short, hind margin widely and subangularly emarginate, posterior lateral angles acute, no dis-

tinct carinæ. Mesonotum tricarinate, slightly flattened between carinæ, hind margin forming about an equilateral triangle. Female with complete ovipositor projecting about two-thirds beyond pygofer, which forms a small, round, wax-secreting area. Posterior tibiæ unarmed.

This genus comes into the Oecleini, in which tribe the bases of Sc, R, and M form a common stalk, thus only two veins arise from the basal cell.

Euryphlepsia amboinensis sp. nov. Plate 1, fig. 8; Plate 2, figs. 1, 2.

Male.—Length, 3 millimeters; tegmen, 3.7. Ochraceous orange or ochraceous buff; slightly darker on carinæ of head and on mesonotum. Tegmina hyaline, ochraceous, veins of same color, apices of apical veins and apical crossveins brownish. Wings hyaline, with ochraceous veins. Lateral margins of pygofer produced into a small subangular projection about middle, medioventral projection conical in outline. Anal segment large and consisting of three pieces, a large basal piece produced into a small process at the sides, a small triangular middle portion and a large, lanceolate apical portion, slightly curved and concave on ventral surface. This apical portion is possibly the anal style. Genital styles large, narrow at base, widest in middle, inner margin convex, outer margin slightly sinuous, apex narrow, very slightly bilobed. Ædeagus complex.

Female.—Length, 3 millimeters; tegmen, 4. Darker than the male; in some specimens the dark markings over the apical veins and crossveins more extensive and the costal cell and clavus quite fuscous.

Described from specimens from several localities. The type consists of a male and a female from Amboina (*Muir 1036*). Among the paratypes are both light and dark females as follows: Seven dark females from Amboina and one from Piroe, Ceram (*Muir*); two males and three females from Sandakan, Borneo (*Baker 10063*), which are darker than the Amboina males; two light males and four dark females from Dapitan, Mindanao (*Baker 4413, 4415, 13349*); one dark female from Butuan, Mindanao (*Baker 10075*); one dark female from Malinao, Tayabas, Luzon (*Baker*); one light male from Kolambugan, Mindanao (*Baker 13643*); one dark female from Puerto Princesa, Palawan; one light male and four light females from Mount Maquiling, Luzon (*Baker 1323, 9350, 9364, 10068; Muir*).

This species was named and described before I found that the Ceram, Borneo, and Philippine specimens were the same.

Euryphlepsia papuaensis sp. nov. Plate 2, fig. 3.

Male.—Length, 2 millimeters; tegmen, 3. Only four median apical veins, M_4 lacking. Transverse carina of vertex obscure. Lateral margins of pygofer produced into a thin, small, acute spine in the middle, medioventral margin produced into a quadrate process longer than wide with the apex narrower than base. Anal segment truncate at apex, each apical angle produced into a long, thin, curved spine, anal style small. Genital styles small, laterally flattened, curved, apex truncate and slightly wider than base. Brown; lateral carinæ of head, labium, legs, and pronotum lighter. Tegmina hyaline, brownish, lighter in middle of apical and subapical cells. Wings hyaline, slightly fuscous, veins dark.

Female.—Length, 2.6 millimeters; tegmen, 3. Similar in color to male. Anal segment longer than broad, slightly flattened horizontally, apex truncate.

PAPUA, Laloki River (*Muir 1909*), 1 male and 4 females. Type No. 1037.

Euryphlepsia pallidifrons sp. nov. Plate 2, fig. 4.

Male.—Length, 2.7 millimeters; tegmen, 3.2. Lateral margins of pygofer produced into a small, acute spine in middle, ventral margin produced angularly in middle. Anal segment large, anus slightly before apex, each apical corner produced into a long, strong spine nearly as long as segment and, in lateral view, at right angle to segment. Genital styles large, angular near base, apex truncate, oblique, outer margin concave. Head, lateral portion of pronotum, and legs pale yellow; mesonotum and abdomen brown. Tegmina hyaline, fuscous brown, lighter on apical and preapical cells.

Female.—Length, 2.6 millimeters; tegmen, 3. In color similar to the male.

BORNEO, Sandakan (*Baker*), 1 male and 1 female. Type No. 1038.

Euryphlepsia lineata sp. nov. Plate 2, fig. 5.

Male.—Length, 3 millimeters; tegmen, 3.5. Stramineous; tegmina hyaline, stramineous, veins slightly darker, slightly fuscous over first two apical median cells and clavus. In lateral view lateral margins of pygofer slightly rounded, medioventral edge conically produced with a minute projection at each side of its base. Anal segment short, anus before apex, lateral margins at apex produced into a broad, flat angle, anal style small. Gen-

ital style small, narrow, angled and narrow in middle, apex truncate, slightly widened.

Female.—Length, 3 millimeters; tegmen, 3.8. In color similar to male but the lateral portions of the mesonotum brown and the dark color continuous over clavus and along tegmen to apical median cells. Wings hyaline with brown veins.

BORNEO, Sandakan (*Baker 10059, 10062, 10065*), 4 males and 6 females. Type No. 1039.

Euryphlepsia flava sp. nov. Plate 2, fig. 6.

Male.—Length, 2.6 millimeters; tegmen, 3.2 Yellow; tegmina hyaline, slightly flavous, veins darker. Wings hyaline, veins light. Lateral edge of pygofer slightly and subangularly produced in middle, medioventral process subconical in outline. Anal segment fairly large, anus before apex which is asymmetrically produced into a squarish process on the left side of apex. Genital styles slightly curved; broadest at apex, which is truncate.

BASILAN (*Baker*), 2 males.

Genus **STENOPHLEPSIA** novum

Type, *Stenophlepsia flava* sp. nov.

Head and thorax as in *Euryphlepsia,* the median ocellus obscure, or even lacking in some specimens. Female ovipositor complete, projecting beyond apex of abdomen. Pygofer of female forming a round, wax-bearing area. Hind tibiæ unarmed.

Sc and R forking a little before middle of tegmen, M joining Sc + R near the base. Two apical branches to R and five to M. Stigma large. Claval vein entering commissure near apex, commissure of clavus thickened; forking of claval veins about middle of clavus (Plate 2, fig. 7).

This genus differs from *Myndus* Stål in having a distinct subantennal process. It differs from *Euryphlepsia* g. nov. in having no thickening of Sc + R + M, or only at the extreme base, and M only joins Sc + R near base.

Stenophlepsia flava sp. nov. Plate 2, figs. 7, 8.

Male.—Length, 3.3 millimeters; tegmen, 4.6. Yellow; tegmina hyaline, veins stramineous, the apical portion of the apical veins and the apical crossveins fuscous; clavus between veins and commissure dark, opaque. Wings hyaline, veins brown, fuscous over anal area. Lateral margins of pygofer produced into two small, quadrate processes about the middle, medioventral margin produced into an angular process. Anal segment large, anus

before apex, lateral edges near apex produced into a large process with rounded apex. Genital style flattened laterally, angular before middle, broadest at apex where it is truncate and slightly oblique.

Female.—Length, 3.4 milimeters; tegmen, 4.7. In color similar to male.

LUZON, Laguna Province, Mount Maquiling and Los Baños (*Baker 2503; Muir*), 4 males and 3 females. Type No. 1042.

Stenophlepsia fasciatipes sp. nov. Plate 2, fig. 9.

Male.—Length, 2.7 millimeters; tegmen, 3. Face, clypeus, genæ, and lateral portions of pronotum stramineous; vertex, middle of pronotum, mesonotum, and abdomen brown. Front legs with coxæ and femora dark, tibiæ light; middle femora dark, a dark band on tibiæ and on tarsi; hind tibiæ with a dark band about middle, another at apex and base of basitarsus and another small band on second and third segments of tarsi. Tegmina dark brown with lighter marks in apical portion of apical cells. Wings fuscous, veins dark. Middle of lateral margins of pygofer produced into a small, subquadrate process, ventral edge in middle produced into a subtriangular process. Anal segment fairly short, apex rounded, not produced. Genital styles curved, gradually widened to apex which is round.

Female.—Length, 3 millimeters; tegmen, 3.4. Similar in color to male.

MINDANAO, Davao, 1 male. BASILAN (*Baker 13641*), 1 female. Type No. 1043.

Stenophlepsia brunnea sp. nov. Plate 2, fig. 10.

The base of Sc + R is slightly thickened but M does not join them till near the base. I therefore include it in this genus.

Male.—Length, 2.7 millimeters; tegmen, 3. Head, legs, and pronotum stramineous, mesonotum and abdomen brown. Tegmina hyaline, brown, veins dark, small light spots in the middle of subapical and apical cells. Wings hyaline, fuscous, veins dark. Lateral margins of pygofer slightly angular in middle, medioventral margin produced into an angular process. Anal segment small, anus before apex, apex asymmetrical, the left side being produced into a subquadrate process; anal style small. Genital styles very thin, long, slightly curved, apex rounded.

Female.—Length, 2.7 millimeters; tegmen, 3. In color similar to male but slightly darker.

LUZON, Laguna Province, Mount Maquiling and Los Baños (*Baker 10069; Muir*), 2 males and 5 females. Type No. 1040.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Kinnara* Distant, left tegmen.
2. *Kinnara spectra* Distant, lateral view of male genitalia.
3. *Kinnara flavofasciata* Distant, lateral view of lower portion of male pygofer and left style.
4. *Kinnara penangensis* sp. nov., right anterior style of female.
5. *Kinnara nigrolineata* sp. nov., lateral view of lower portion of male pygofer and left style.
6. *Kinnara bakeri* sp. nov., lateral view of male genitalia.
7. *Kinnara marginalis* sp. nov., lateral view of lower portion of male pygofer and left style.
8. *Euryphlepsia amboinensis* sp. nov., left tegmen.

PLATE 2

FIG. 1. *Euryphlepsia amboinensis* sp. nov., lateral and front view of head.
2. *Euryphlepsia amboinensis* sp. nov., lateral view of male genitalia.
3. *Euryphlepsia papuaensis* sp. nov., lateral view of male genitalia.
4. *Euryphlepsia pallidifrons* sp. nov., lateral view of male genitalia.
5. *Euryphlepsia lineata* sp. nov., lateral view of male genitalia.
6. *Euryphlepsia flava* sp. nov., lateral view of male genitalia.
7. *Stenophlepsia flava* sp. nov., right tegmen.
8. *Stenophlepsia flava* sp. nov., lateral view of male genitalia.
9. *Stenophlepsia fasciatipes* sp. nov., lateral view of male genitalia.
10. *Stenophlepsia brunnea* sp. nov., lateral view of male genitalia.

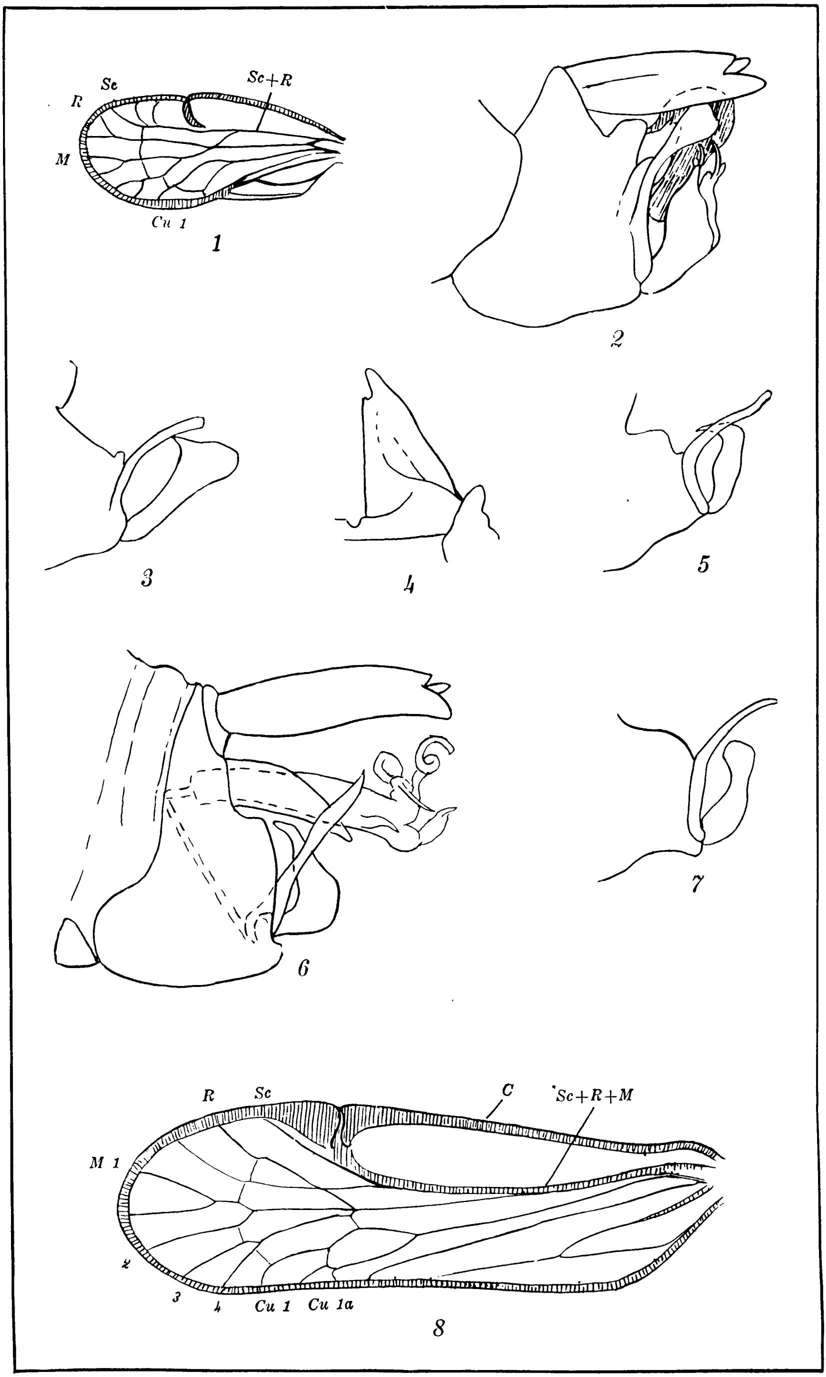

PLATE 1. NEW MALAYAN CIXIIDÆ.

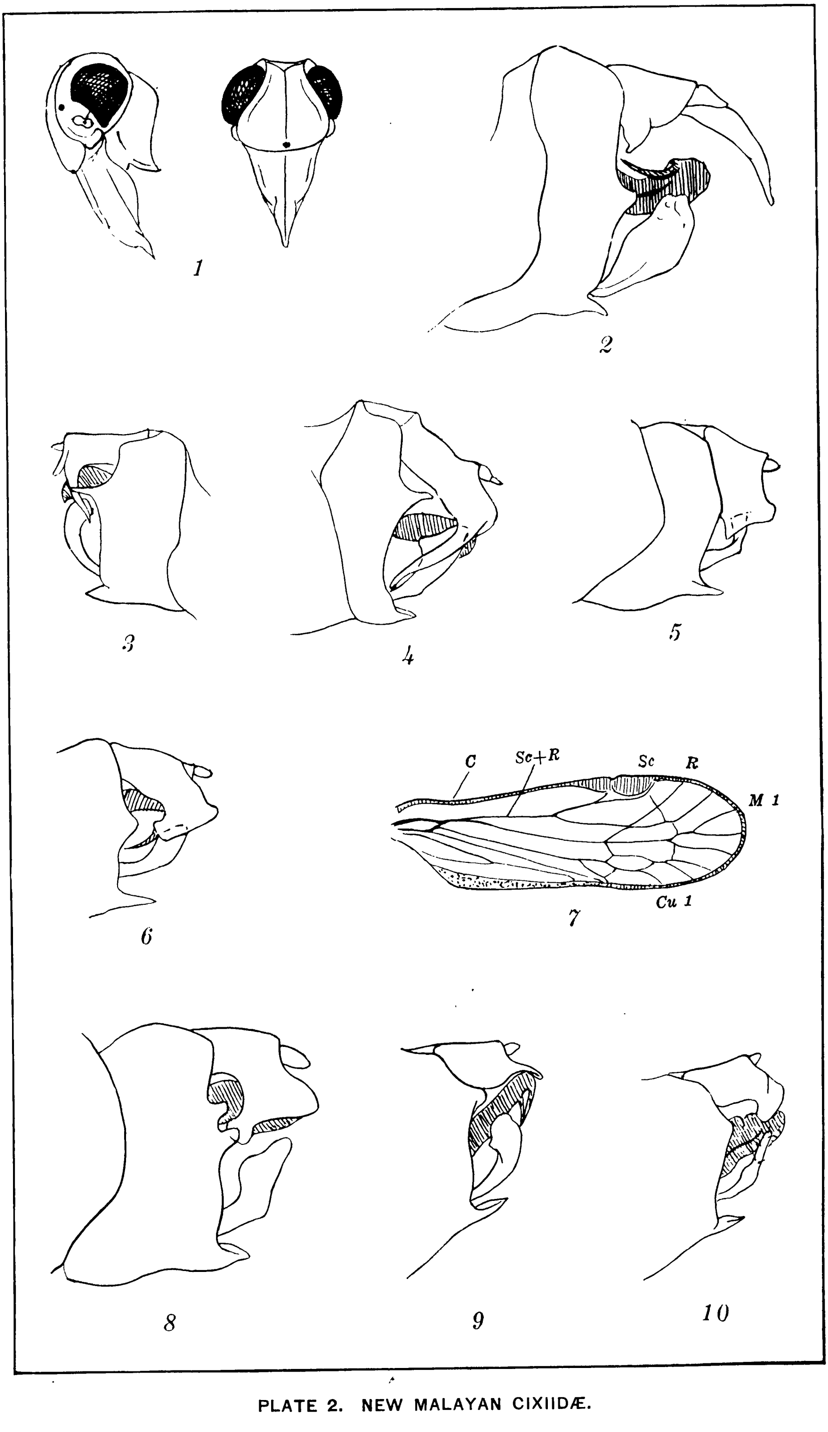

PLATE 2. NEW MALAYAN CIXIIDÆ.

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THE PHILIPPINE
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CITRUS-CANKER CONTROL EXPERIMENTS IN JAPAN

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FOUR PLATES AND ONE TEXT FIGURE

INTRODUCTION

A previous progress report has been presented by the first mentioned of the present writers,(4) in which experiments on the control of citrus canker in the Philippines were described. The conclusions from this report were briefly: That the feasibility of control varied widely according to the different susceptibilities of the citrus species and varieties as hosts. The American-grown grapefruit [*Citrus maxima* (*decumana*)] and West Indian lime (*Citrus aurantifolia*) in the Philippines were

[1] Appreciation is herein expressed to Mr. Gojuhachi Sakai, the owner of the experimental orchard, for considerable assistance throughout the experiments. The writers were also fortunate in having the active collaboration of Mr. Tetsuma Kondo, entomologist of the Nagasaki Ken Agricultural Experiment Station, in connection with the closely related insect problems. Sincere thanks are also expressed to Dr. Carl P. Hartley, of the Instituut voor Plantenziekte, Buitenzorg, for considerable aid as well as suggestions at the time of harvesting the fruits.

The experimental data presented here were obtained while the writers were connected with the United States Department of Agriculture and Nagasaki Agricultural Experiment Station, respectively.

so susceptible to canker as to be very difficult of control; the control of citrus canker on such hosts was not economically feasible in humid climates, by the methods employed. Control had been effected upon the class of citrus varieties of the general susceptibility of the East Indian pummelo (*Citrus maxima*), Washington navel orange (*Citrus sinensis*), and other sweet oranges of Florida origin; however, the feasibility of control from a commercial viewpoint was undetermined. A class of varieties that showed still less susceptibility consisted of the sweet oranges of the Mediterranean group (*Citrus sinensis*), such as the Jaffa, Du Roi, Mediterranean Sweet; some of the American-grown lemon varieties (*Citrus limonia*), the Tahiti lime (*Citrus aurantifolia*), and the Unshiu (Satsuma) orange varieties (*Citrus nobilis* var. *unshiu*). In the Philippines control on such varieties was so readily obtained that its commercial feasibility seemed very probable. The calamondin (*Citrus mitis*), the mandarin orange (*Citrus nobilis* var. *deliciosa*), the round kumquat (*Fortunella japonica*), and some of the citrons (*Citrus medica*) constituted a class of citrus varieties of such slight susceptibility to canker that control measures upon them were unnecessary.

It seemed desirable to try further control measures on an orchard planted exclusively to a variety of the same degree of susceptibility as the Washington navel; this class contains many of the commercially grown varieties, and it seemed important to determine the feasibility of such measures from a standpoint of costs on such a class of hosts. Such further experiments were, therefore, undertaken in an orchard of the Washington navel variety at Saigomura, Nagasaki Prefecture, on Kyushiu Island in southern Japan.

CLIMATIC CONDITIONS IN NAGASAKI PREFECTURE

Temperature, humidity, rainfall, and wind velocity and direction were recorded at the orchard during the actual operations of the experiment. However, to obtain a proper idea of the seasonal conditions, extracts will be presented here from weather data for a five-year period, collected by the Nagasaki Agricultural Experiment Station. The temperature data are shown first, in Table 1.

From Table 1 it can be seen that there is a winter season from early November until the end of April, during which the temperatures are, with a few exceptions, below 20° C. Although the minimum temperature for the growth of the canker organism

in culture is about 5° C. according to Peltier,(5) the minimum temperature for infection and development of the disease upon calamondin (*Citrus mitis*) and grapefruit (*Citrus maxima*) is 20° C. This may be taken roughly as an index of the action on the Washington navel orange (*Citrus sinensis*) ; according to this, then, canker activity from November until the end of April is negligible or entirely absent.

During this period also the rainfall is not heavy and the canker organism is not disseminated seriously. Although in May the rainfall is slightly increased and the temperatures are slightly higher, it may probably be classed with November to April, as a month of canker inactivity in Japan. The rainfall for the year is shown in Table 2.

Table 2 shows a very decided increase in rainfall for June and early July. The Japanese in Nagasaki claim that there are twenty-one days of continuous rainfall always at this season, and the season is called the *nyubei.* Although the definite period of twenty-one days may be doubted, there is a period of from three to four weeks at this time when there is heavy and intense rainfall; this is accompanied by a very perceptible rise in temperature. After the nyubei, there is a period of little rainfall which, in usual years, constitutes almost a dry season. This lasts through July and early August, sometimes to the end of August. During August and September, however, typhoons sometimes are recorded and these, although irregular in occurrence, must be prepared for. The rains accompanying typhoons raise the rainfall total for these months well above that for July and early August. After the September typhoons October is a comparatively dry and cool month.

It was pointed out previously by the first mentioned of the present writers that canker dissemination is largely dependent upon free moisture, rain or dew, on the foliage. As previously mentioned, Peltier has shown that canker infection is dependent on temperature also, varying according to the host, but safely at 20° C. or above. With these factors, rainfall and temperature, in view, it is apparent that usually there are but two periods favorable to canker dissemination and infection in southwestern Japan: (*a*) the period of the nyubei, which may begin any time in early June and extend into July, and (*b*) the period when typhoons may occur, usually from the latter part of August until the end of September. The nyubei is a period of steady, drenching downpours, but with little or no strong wind. The period August and September is not always accompanied

TABLE 1.—*Showing the temperatures at Nagasaki (city) for a five-year period; data from the annual report of the Nagasaki Agricultural Experiment Station for 1917.*

[Numbers indicate degrees centigrade.]

Year.	January.			February.			March.			April.			May.			June.		
	1-10	11-20	21-31	1-10	11-20	21-28	1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31	1-10	11-20	21-30
AVERAGE TEMPERATURE.																		
1907	4.4	11.1	6.1	3.4	4.6	9.1	6.6	6.8	12.4	13.4	13.7	15.3	17.0	16.1	18.8	20.8	20.8	22.2
1908	6.9	4.6	4.6	4.6	6.0	3.6	7.8	8.0	8.0	13.3	13.9	15.1	16.6	15.8	18.7	22.0	20.8	21.3
1909	8.9	5.3	5.8	2.7	4.4	7.9	4.5	8.7	10.4	10.0	14.9	14.9	17.6	17.9	19.6	21.1	22.4	21.2
1910	5.6	3.8	7.9	5.6	6.9	6.9	9.2	9.8	11.0	11.4	13.4	15.1	16.2	17.4	19.9	20.4	21.3	21.8
1911	6.0	3.4	5.6	6.2	6.7	12.6	9.6	7.8	11.4	10.5	14.6	16.8	16.3	18.1	17.7	20.1	20.9	22.4
MAXIMUM TEMPERATURE.																		
1907	8.5	15.2	10.7	6.9	9.0	13.5	10.0	11.6	18.0	18.2	18.7	20.7	21.4	20.4	24.2	24.3	24.0	25.7
1908	11.3	11.0	7.7	8.2	10.3	7.5	13.0	12.0	12.4	18.0	19.2	19.9	21.5	20.6	23.3	25.3	24.0	24.6
1909	8.1	8.5	9.3	6.1	8.2	9.9	8.7	13.3	14.3	14.4	20.0	19.8	21.4	22.8	25.0	24.6	25.7	23.4
1910	10.1	7.3	11.4	10.3	10.2	11.3	12.7	14.3	16.0	16.0	18.6	19.9	20.7	22.1	24.7	24.2	25.1	24.6
1911	9.2	5.9	8.5	10.3	10.8	9.1	13.2	12.2	15.8	14.6	19.1	20.3	21.6	22.3	22.2	24.5	25.0	26.6
MINIMUM TEMPERATURE.																		
1907	1.6	7.0	2.4	0.1	1.2	4.6	4.0	4.0	6.5	9.6	8.1	11.3	12.8	11.9	14.4	16.3	18.0	19.3
1908	3.4	3.4	1.5	1.2	1.9	1.0	3.8	5.7	4.0	8.5	9.5	11.3	12.8	7.1	14.5	17.4	17.2	16.9
1909	1.7	2.6	3.6	0.2	1.8	2.8	1.3	5.1	7.3	5.7	9.7	10.5	14.0	13.6	14.8	15.0	19.7	19.0
1910	1.3	0.5	3.9	1.3	3.3	3.2	5.6	6.2	6.2	7.5	9.2	10.4	12.1	13.6	15.8	16.9	12.0	18.3
1911	3.4	1.3	1.9	3.5	3.1	7.6	6.3	4.2	7.6	7.0	9.6	13.2	12.3	14.3	13.9	15.7	22.8	18.5

AVERAGE TEMPERATURE.

Year.	July.			August.			September.			October.			November.			December.		
	1-10	11-20	21-31	1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31
1907	21.4	23.8	27.1	26.8	26.3	25.4	25.5	21.6	19.9	18.7	17.2	18.2	14.0	10.5	9.4	9.3	9.3	7.7
1908	22.4	26.9	27.0	27.1	26.6	25.9	25.6	25.6	22.1	18.3	18.7	15.8	15.4	12.5	11.5	8.5	5.3	7.2
1909	23.6	26.3	27.3	26.5	25.5	26.5	25.0	22.0	21.5	18.3	16.2	16.9	14.0	10.5	12.1	6.3	4.6	5.9
1910	23.2	26.2	25.3	25.7	26.8	26.4	25.3	24.9	23.2	19.4	15.6	16.1	13.3	14.9	11.3	8.8	6.8	5.2
1911	22.1	25.3	25.2	26.1	26.2	26.3	25.0	20.7	19.8	17.6	16.1	16.8	13.0	8.9	9.8	7.4	9.9	6.2

MAXIMUM TEMPERATURE.

Year.	July 1-10	July 11-20	July 21-31	Aug. 1-10	Aug. 11-20	Aug. 21-31	Sept. 1-10	Sept. 11-20	Sept. 21-30	Oct. 1-10	Oct. 11-20	Oct. 21-31	Nov. 1-10	Nov. 11-20	Nov. 21-30	Dec. 1-10	Dec. 11-20	Dec. 21-31
1907	23.2	28.1	31.3	32.8	30.6	29.6	30.7	25.6	23.8	22.7	21.3	22.6	17.7	15.1	13.1	18.2	13.7	11.8
1908	26.4	31.0	31.2	27.8	31.0	30.5	30.0	29.5	26.9	22.2	23.8	19.5	19.1	17.3	15.5	12.5	8.5	11.1
1909	27.1	30.5	32.4	31.8	29.6	34.0	29.2	25.7	25.2	22.2	20.8	22.4	18.4	15.1	16.5	8.9	8.1	9.9
1910	26.6	30.1	29.1	29.7	31.0	30.7	26.5	28.7	26.7	22.5	19.6	20.9	17.9	19.1	14.1	12.5	10.5	8.0
1911	25.1	27.4	27.8	30.7	30.7	30.6	28.9	23.5	23.9	21.6	21.1	21.0	16.4	12.9	13.9	11.3	8.8	9.4

MINIMUM TEMPERATURE.

Year.	July 1-10	July 11-20	July 21-31	Aug. 1-10	Aug. 11-20	Aug. 21-31	Sept. 1-10	Sept. 11-20	Sept. 21-30	Oct. 1-10	Oct. 11-20	Oct. 21-31	Nov. 1-10	Nov. 11-20	Nov. 21-30	Dec. 1-10	Dec. 11-20	Dec. 21-31
1907	18.8	20.5	24.9	21.3	23.1	21.9	21.6	19.3	17.0	15.3	12.8	15.2	10.8	5.8	6.2	6.5	5.8	4.4
1908	20.9	23.5	23.3	23.8	23.6	22.7	22.6	22.5	19.3	14.9	14.7	12.0	11.9	8.8	7.8	5.0	2.0	3.7
1909	21.2	23.3	23.3	23.8	22.0	23.0	22.2	18.7	23.8	15.4	12.8	13.7	10.6	7.3	8.5	3.5	1.4	2.8
1910	20.5	23.1	22.0	21.9	23.2	23.2	20.6	22.0	22.0	16.5	12.1	10.4	9.2	11.2	8.1	6.5	3.3	2.8
1911	13.9	23.5	22.9	23.7	22.7	22.5	20.8	17.4	16.0	13.8	11.6	13.6	10.1	5.7	7.8	3.9	6.4	3.0

TABLE 2.—*Showing the precipitation in millimeters at Nagasaki for a fifteen-year period; data from the annual report of the Nagasaki Agricultural Experiment Station for 1917.*

Year.	January.			February.			March.			April.			May.			June.		
	1-10	11-20	21-31	1-10	11-20	21-28	1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31	1-10	11-20	21-30
1897	70.8	7.8	56.9	38.4	18.6	88.6	7.8	20.1	84.5	25.7	21.0	9.0	86.9	133.1	34.0	130.4	37.9	44.0
1898	10.8	4.5	26.7	8.3	43.8	114.4	51.0	30.6	45.9	13.8	102.0	41.6	39.9	46.8	21.3	161.1	85.8	109.2
1899	11.5	18.9	31.1	17.9	4.9	....	12.6	21.5	36.2	93.6	149.7	38.1	89.1	66.8	95.2	10.6	19.3	55.8
1900	18.4	33.9	55.4	12.8	81.2	13.8	47.5	5.6	12.8	44.3	99.0	17.3	50.0	18.0	40.4	95.0	15.8	436.4
1901	8.8	4.3	38.3	17.9	11.7	32.6	27.4	12.8	120.5	102.4	43.9	109.2	180.3	89.9	41.4	49.4	123.8	31.1
1902	23.5	27.6	72.7	25.0	24.5	40.1	19.8	56.5	36.4	11.2	202.2	244.5	29.6	194.2	48.7	86.1	8.9	17.7
1903	1.2	38.5	6.7	15.3	20.1	25.4	86.0	17.7	23.1	53.6	55.5	136.7	23.4	27.5	61.8	15.7	114.2	17.7
1904	27.7	23.7	28.3	15.2	12.3	55.6	23.3	79.5	70.2	4.8	129.7	56.5	79.6	23.2	49.3	147.7	134.8	112.4
1905	39.9	34.3	18.7	49.3	19.7	65.4	15.6	42.4	66.1	19.0	3.9	31.7	67.7	154.8	76.2	87.0	118.4	145.6
1906	4.8	21.1	56.1	52.5	12.9	2.9	28.2	23.5	72.8	88.0	46.9	28.1	136.0	14.2	29.5	58.0	158.0	38.2
1907	4.5	17.5	2.7	13.4	0.4	5.2	30.6	18.9	9.6	161.9	58.5	68.6	32.4	75.4	19.0	6.4	54.8	183.4
1908	11.6	30.2	25.7	15.3	54.0	3.1	58.5	64.1	71.6	35.8	75.0	43.7	37.1	20.2	13.4	66.2	67.0	238.6
1909	63.6	81.8	20.4	18.6	18.4	24.9	11.8	40.2	100.8	74.2	16.2	124.5	69.1	16.6	5.9	21.8	247.4	149.2
1910	38.6	3.1	53.0	2.5	33.5	5.3	120.6	65.0	44.3	84.8	30.8	45.9	39.1	41.8	85.7	72.1	256.8	189.4
1911	40.0	3.4	21.7	17.6	32.1	140.2	51.3	11.7	109.4	72.2	1.9	106.4	32.1	27.0	9.4	67.5	133.8	20.9
Average	25.0	23.3	36.3	21.3	22.5	40.8	39.5	34.0	60.9	59.0	68.7	74.1	65.5	63.3	40.2	71.7	105.7	141.4

Year.	July.			August.			September.			October.			November.			December.		
	1-10	11-20	21-31	1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31
1897	62.3	0.1	103.4	18.0	101.7	77.4	19.2	36.2	47.7	42.4	13.8	5.1	21.1	62.1	79.7	13.9	33.7	35.8
1898	14.9	30.7	44.8	48.7	239.0	32.9	68.3	75.3	13.9	1.4	51.0	18.5	27.0	53.6	4.1	2.2	63.6	56.3
1899	528.8	216.4	1.6	12.4	54.7	102.0	156.9	9.6	22.2	71.0	71.6	18.4	39.4	45.1	53.9	28.2	8.6	4.2
1900	187.7	221.8	45.3	25.0	83.6	5.2	9.3	66.0	0.4	180.1	8.0	7.4	3.7	35.8	3.6	11.5	8.6	12.2
1901	29.7	71.0	87.8	100.2	118.6	52.7	112.6	0.1	63.6	0.1	43.8	87.6	44.2	6.9	45.7	37.2	27.6	33.6
1902	92.1	238.9	76.3	45.4	1.5	13.9	3.2	145.9	8.5	55.9	8.4	31.5	14.2	12.5	27.5	25.0	36.7	6.8
1903	11.8	17.4	28.9	7.5	64.9	1.5	36.1	35.5	2.0	9.7	35.6	8.9	3.9	65.6	7.7	5.8	20.8	21.1
1904	82.1	174.4	186.9	87.0	221.7	175.1	97.8	9.5	8.5	11.5	41.9	37.4	34.0	10.9	0.6	14.5	37.3	95.4
1905	29.9	47.4	7.2	72.9	60.4	3.0	251.2	89.1	23.6	76.1	3.4	70.4	1.0	13.9	6.4	19.8	31.0	22.9
1906	186.4	95.3	1.6	49.4	3.1	0.4	127.0	21.3	104.3	34.6	83.2	8.0	10.5	41.5	81.1	30.9	4.1	9.5
1907	168.4	67.5	4.4	34.5	57.0	67.2	------	79.2	66.5	31.8	79.4	20.9	16.9	3.2	0.5	1.7	31.3	48.4
1908	188.5	20.7	43.1	57.2	89.3	17.2	104.4	305.3	79.3	11.1	15.1	70.5	40.1	------	22.3	10.8	10.9	54.1
1909	85.3	13.1	8.9	14.4	22.0	93.1	390.6	51.0	10.4	59.6	57.8	------	76.0	15.2	35.8	4.2	6.7	15.4
1910	61.9	2.1	154.8	57.1	9.1	52.3	250.1	136.5	71.0	98.7	6.5	1.1	19.4	45.5	88.7	30.0	14.2	33.7
1911	214.4	133.6	224.1	4.9	2.1	28.8	67.5	109.1	11.3	57.1	3.8	55.7	21.1	38.5	2.9	20.3	41.6	46.7
Average	129.6	90.0	67.9	42.3	75.2	68.2	112.9	78.0	35.5	49.4	34.9	32.5	24.8	29.9	27.3	17.0	25.1	33.0

by typhoons; but, when such storms occur, the winds are usually accompanied by rain and conditions are extremely favorable for canker dissemination as well as infection.

The seasons in Nagasaki Prefecture, from the viewpoint of activity for canker dissemination and infection, may be approximately grouped as shown in Table 3.

TABLE 3.—*Showing climatic periods in Nagasaki Prefecture, favorable or unfavorable for citrus-canker development.*

November, December, January, February, March, and April:

Temperatures usually below 20°C. Rainfall slight; canker dissemination and development very slight, if at all active. No foliage or fruit development of host plants during the period November to March.

May:

Temperatures usually below 20°C. and rainfall usually low. No growth of foliage during this period.

June and July:

Temperatures increased and favorable for canker development. Rainfall increased, frequently intense, favorable for canker development. The fruit and foliage of the host plant growing actively and favorable for canker infection.

Late July and early August:

Temperatures favorable for canker development, but rainfall slight; under ordinary seasonal conditions not a period for serious canker development.

August and September:

A period of possible typhoons with high wind velocities and intense rainfall, favorable for the dissemination and development of citrus canker. There is little foliage growth at this time but fruit development is taking place and the fruit tissues are in a susceptible stage.

October and November:

The temperatures become lower very abruptly in usual years; rainfall also is very slight. The fruit is so nearly mature as to be no longer susceptible, and no foliage growth takes place at this season. This is a period in which canker activity may be disregarded.

With this perspective of the seasonal conditions, the control campaign was outlined to apply protective spray coatings during the critical seasons of the nyubei in June and the period of probable typhoons in late August and September; how this was done will be shown in detail in the following pages.

EXPERIMENTAL METHODS AND ORCHARD CONDITIONS

The orchard conditions can best be appreciated by an extract from the writers' notebook written before the experiments were undertaken.

Saigo is in Nagasaki Prefecture in the southern part of Kyushiu Island. The town of Saigo is on the sea while the orchard is about 3 kilometers inland and in the foothills of Mount Unsen; the orchard is at an elevation of about 60 meters above sea level.

The Saigo region is not planted much to oranges. This orchard stands in the foothills, surrounded on the mountain side with scrub pine trees while toward the town are scrub pines with a few barley and soy-bean fields; there are no other orchards near at hand. This orchard is surrounded by several rows of some sort of coniferous tree making a fairly good windbreak on all sides. At the present time (December) the northeast monsoon comes right off the sea and hits the orchard; the force of the wind, however, is somewhat broken by this windbreak.

The orchard consists of about 6 hectares of navel orange trees said to be eighteen years old. The trees are planted on *Citrus trifoliata* stock and are consequently somewhat dwarfed, nevertheless they stand well above a man's head, 2.5 to 4 meters high, and are very broad and compact. They are headed low, in much the same manner as California trees.

The land has a decided slope but not so great that a wagon or sled cannot be pulled in all directions. In some places the orchard is terraced but it will be possible to select plats between such terraces. The orchard has been well cultivated (by hand) and is in fine growing condition. Fertilizers, soy-bean cake, and a fish-product fertilizer are applied abundantly in the spring, according to the owner. He has been bothered considerably by the fruits becoming badly blemished by canker and would welcome anything which would prevent the trouble.

An idea of the size and character of the trees and the state of cultivation of the orchard may be obtained from a photograph of the orchard shown in Plate 1.

The arrangement of the experimental plats is shown in fig. 1.

The pruning indicated in plats 1, 2, 3, 4, and 5 in fig. 1 was extremely careful, an effort being made to eliminate all cankers or at least to reduce them to but a few. As much as three hours were sometimes spent to a tree. In plats 13, 14, 15, 16, and 17 more rapid pruning was attempted and this was called "rough pruning," by the Japanese. In the case of these plats the sources of infection were greatly reduced, but no attempt was made to eliminate entirely the foliage cankers or to reduce them to but a numerical few.

The cost of these methods of pruning was recorded and is shown in Table 4.

The spray mixtures indicated in fig. 1 are so commonly used as to require little explanation. Lime sulphur at a concentration of 32° Baumé was used in a 1 to 40 dilution with water, unless otherwise noted. Bordeaux 4–4–50 mixture was prepared in the usual way, adding diluted and recently slaked quicklime to a dilute copper sulphate solution; it was used immediately after preparation. Neutral Bordeaux mixture was prepared

by adding the diluted, recently slaked quicklime in just sufficient amount to precipitate entirely all of the copper. Burgundy 3–3–50 mixture was always prepared with diluted constituents and applied immediately after its preparation. Formalin 1 to 100 was always applied immediately after its preparation. Spray solutions and mixtures were applied with a pump operated by hand; the pump was equipped with a pressure gauge and pressure was maintained at from 120 to 140 pounds.

TABLE 4.—*Showing cost of labor employed in removal of sources of infection.*

CAREFUL PRUNING, PLATS 1, 2, 3, 4, AND 5.

Date.	Men.	Hours.	6-hour days.	Cost at Y 1.20 per day.
				Yen.
December 29, 1918	11	66	11	13.20
	2	6	1	1.20
December 30, 1918	8	56	9.3	11.20
	1	3	0.5	0.60
	1	4	0.6	0.80
December 31, 1918	9	36	6	7.20
	8	12	2	2.40
	1	3	0.5	0.60
	6	39	6.5	7.80
January 4, 1919	2	9	1.5	1.80
January 6, 1919	8	64	10.6	12.80
Total		298	49.5	59.60
ROUGH PRUNING, PLATS 13, 14, 15, 16, AND 17.				
December 31, 1918	4	6	1	1.20
January 5, 1919	3	3	0.5	0.60
January 6, 1919	2	1	0.16	0.20
January 7, 1919	3	10	1.66	2.00
	2	6	1	1.20
Total		26	4.32	5.20

Careful pruning of 100 trees cost 59.60 sen per tree.
Rough pruning of 50 trees cost 10.40 sen per tree.

The dates of field operations follow, in Table 5.

TABLE 5.—*Showing treatment of the experimental plats for citrus-canker control at Saigomura, Japan.*

Plats 1, 2, 3, 4, 5, pruned December 29, 30, and 31, 1918; January 4 and 6, 1919.

Plats 13, 14, 15, 16, 17, pruned December 31, 1918; January 5, 6, and 7, 1919.

First spray application, June 3, 4, 5, and 6, 1919.
Second spray application, June 24, 25, and 26, 1919.
Third spray application, August 24 and 25, 1919.

The pruning listed above being made in early winter the following extracts from the notes in the succeeding May are of interest:

Upon none of the trees, those of untreated plats as well as those of treated plats, was there foliage young enough to be susceptible. All of the trees

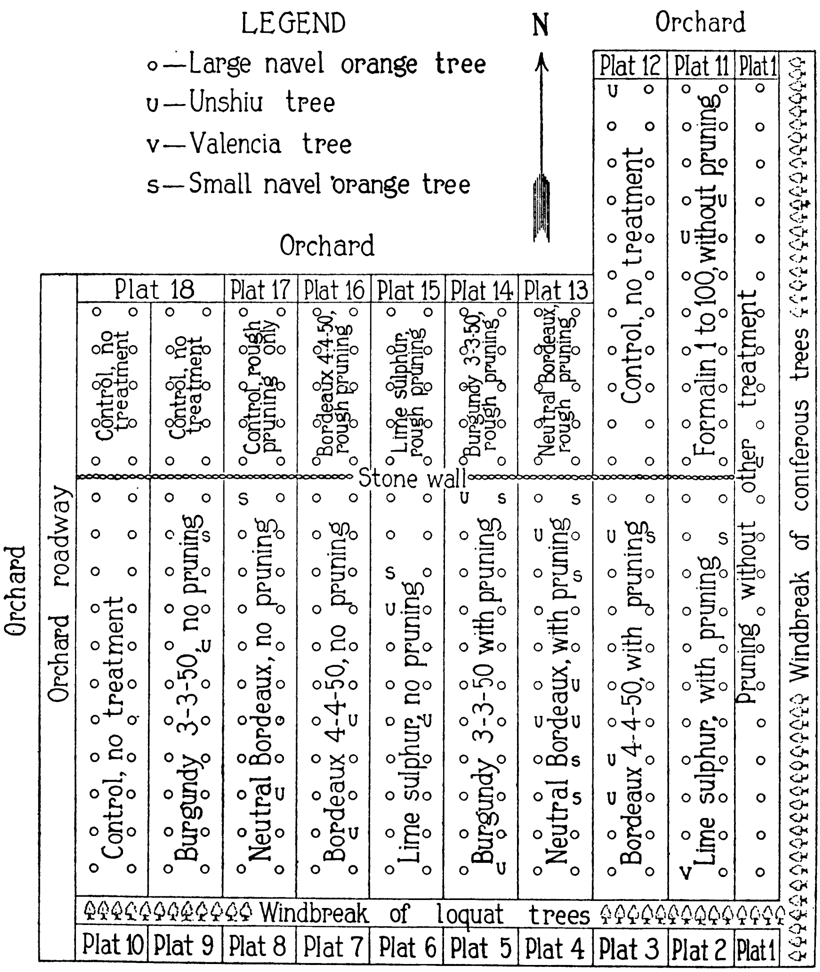


FIG. 1. Showing the arrangement of the experimental plats in the Washington navel orchard at Saigomura, Japan. Plat 19 lies south of the plats shown above.

showed some growth, new since last winter, but this was all well hardened and matured, and considered to be past the stage for development of infection. The pruned plats showed considerably more of this type of foliage than did the untreated plats. All of the trees showed that many of the old leaves had dropped during the winter and the trees were largely foliated with leaves formed since last January. The total amount of foliage of the trees in the pruned plats was appreciably greater than that of the trees in unpruned plats. A considerable drop of the young, newly formed fruits was observable throughout the orchard. Although time did not permit of an actual count, the observations indicated that the fruit drop was considerably less on the pruned plats than on the unpruned plats. Altogether, the general thrift of the pruned plats was very much greater than that of the untreated plats.

The field notes following the second application may also be of interest.

DISCUSSION OF SPRAYING METHODS, SECOND APPLICATION, 1919

Lead arsenate, neutral, was added as a paste, at the rate of 2 pounds for every 50 gallons of spray; this was used uniformly throughout all sprayed plats. The purpose was to check the chewing insects which have been very numerous in the past few months. What Mr. Kondo calls blister moth has also been very common, and this was observed last fall to be very active in disseminating canker. It is hoped that the lead arsenate will be a means of checking this dissemination of canker.

Careful examination was made of the trees in the different plats. Several trees in the control plats showed very new cankers. Two trees in the formalin plats showed no foliage or fruit cankers as yet.

On plats 2, 6, and 15 there was a slight leaf fall. These plats were sprayed with lime sulphur (of a density of 25° Baumé) 1 part to 33 parts of water, plus 2 pounds of lead arsenate (neutral paste) to 50 gallons of solution. The mature, well-formed leaves were the ones that dropped, while the young, new, actively growing leaves were apparently not injured. There was no visible lesion of any sort on the fallen leaves. The loss of leaves was not serious, and apparently no well-formed fruits were caused to drop. The trees are at present in a condition in which they need all possible leaf surface and the leaf drop is regrettable from that standpoint.

On the formalin 1 to 100 plat (plat number 11) there was also a slight leaf drop. This plat was sprayed with formalin 1 to 100, plus lead arsenate (neutral paste) in the proportion of 2 pounds to 50 gallons of the mixture. In this case, however, the affected leaves were the young, actively growing, light-colored ones, while the matured leaves showed no ill effects whatsoever. Upon the fallen leaves and upon the young leaves upon the tree, white-colored, killed areas of tissue showed where the formalin mixture had injured the tissue. There were no indications whatsoever of injury on the fruit.

Careful examination of the plats for new cankers was made. On the pruned plats numbers 1, 2, 3, 4, and 5 no new canker lesions were observed. Some new lesions were observed in sprayed but unpruned plats; such lesions were all foliage cankers, however, and no fruit infections were seen. They were, at this time, so few as to cause no alarm. Upon the unsprayed plats, those entirely untreated, considerable amounts of new

foliage infections were to be observed; no infections were observed on the fruits. Three trees of the formalin plat showed a considerable amount of new foliage infections but no fruit infections.

A careful examination was made for indications of an outbreak of ruby scale but no signs were visible at this time. If the scale insects remain as they are, without perceptible increase, the insecticide application planned for the latter part of July will be omitted.

Leaf samples were brought back to Nagasaki and tested for the amounts of copper remaining on the foliage. The test used was the method described by Winston and Fulton: (7) dissolving the copper compounds on the leaves in a dilute nitric acid solution, testing this wash solution with potassium ferrocyanide, and comparing the resulting color formed with the coloration formed in solution having a known copper content. The results were as follows:

Bordeaux 4–4–50 applied June 24; tested July 2, 50 m. g. Cu per 100 grs. of leaves.

Bordeaux neutral applied June 24; tested July 2, 40 m. g. Cu per 100 grs. of leaves.

Burgundy 3–3–50 applied June 25; tested July 2, 40 m. g. Cu per 100 grs. of leaves.

These results should be compared with tests made June 17 on the adherence of copper sprays, as follows:

Bordeaux 4–4–50 applied June 5; tested June 17, 45 m. g. Cu per 100 grs. of leaves.

Burgundy 3–3–50 applied June 6; tested June 17, 40 m. g. Cu per 100 grs. of leaves.

Bordeaux neutral applied June 6; tested June 17, 60 m. g. Cu per 100 grs. of leaves.

Lime sulphur applied June 4; tested June 17, showed no trace of sulphur remaining on any parts of the foliage.

It will be seen that the copper-precipitate sprays adhere very well; but aside from this no conclusions as to their relative adherence are possible at this time.

The following extracts are taken from the field notes made following the third application, August 25, 1919:

In the sprayed and unpruned plats the fruits are for the most part entirely free of canker at this time; there are a few cases, usually in the tops of the trees, where fruits have been badly whipped by nearby branches and where canker has then resulted severely. Such infections are white in color and apparently new; it would seem probable that they are a result of the typhoon on August 16 and 17. At present the Burgundy and neutral Bordeaux plats show up to the best advantage, but such a statement is only an opinion, and substantial results will be obtained only at fruiting time. The lime-sulphur results are decidedly not equal in value to the results from the copper sprays; there are three to five fruits under each tree in the lime-sulphur plat, that fell due to canker infection; and on each tree there is a number of fruits badly cankered. This is a decided contrast to the results on the Burgundy and Bordeaux plats, where a search has to be made to find an infected fruit.

The pruned plats are still in fine condition; there are few or no foliage infections, and not a fruit has been seen to be affected as yet. Apparently the crop is not so heavy, however, on these pruned plats as upon the unpruned plats.

The formalin plat is in much the same condition as are the untreated plats; the fruits fallen from canker infection are scattered around on the ground almost as thickly as is the case with the untreated plats. Many fruits are badly affected on the tree. On this plat it is necessary to hunt for uninfected fruits.

The insect called the blister moth is present in abundance; this is *Phyllocnystis soligna* Zell., according to Kondo. It is a leaf miner and is found throughout the orchard on all young twigs and leaves. It is the most serious of the agents for dissemination of canker; along the trails of this insect, canker always develops heavily, while nearby tissue on which the leaf miner has not operated will be free from canker. The blister moth is very difficult to control, according to Kondo, and he can suggest no remedy.

Extracts from the field notebook continued:

September 9, 1919. Canker developed on some of the sprayed but unpruned plats and to a considerable degree on some of the fruits. Attention was called by the owner to the occurrence of all cankered fruits on the southwest side of the tree while on the northeast side the fruits were free of canker. This was made a point of careful observation and was noted to be true in every case on the sprayed plats. In the case of the controls the cankers were on all sides, but somewhat worse on the southwest side. This is evidence to some extent that infection took place at the time of the typhoons in August, for the wind at that time came from the south and swept across the orchard from the southwest. On the west side of the orchard, within the protection of the windbreak, there is little or no injury of this type but on the eastern side, where the sprayed plats are, there is considerable evidence of wind injury. On many of these trees in the eastern part, twigs can be commonly observed broken off by the force of the wind.

Further evidence that these cankers developed from infection at the time of the typhoon is contained in the data resulting from artificial inoculations on fruits, made under natural conditions.

Artificial inoculations made July 27, 1919, had developed and were well matured on August 25, 1919. Cankers upon the sprayed plats were not visible, except in a few cases, at this time. Inoculations made August 25 have not developed at the present time, whereas there are now a number of cases of infection on fruits in trees on the sprayed plats. Such infection must therefore have taken place between July 27 and August 25.

The weather reports show only two periods during this time in which the climatic conditions were such as to disseminate canker, these periods being during August 2, 3, and 4, a typhoon, and during August 14, 15, and 16, another typhoon. Both of these storms were unexpected and the trees were entirely unprotected by sprays. In the next year, in addition to two applications in June, another application will be made August 1 to safeguard fully the trees against infection which may be made possible by typhoons in August.

Examination was made to observe the effect of the copper sprays in increasing scale insects. Ruby scale was observed to a very slight degree, but not seriously. Some ruby scale was observed upon trees in the lime-sulphur plat, but less than on the other plats. No other scale insects were serious. The blister moth, *Phyllocnystis soligna* Zell., was observed to be equally injurious on all plats. Apparently there was no reduction in the injury from this insect in the lime-sulphur plats; nor is there any evidence to show that the lead arsenate has caused reduction. This insect is the most active agent in disseminating citrus canker in the Japanese orchards.

In the light of future developments it is interesting to note that there were no indications at this time of red spider.

To supplement these field notes, the climatological data collected at the orchard during the experiments are presented here; the temperature and humidity data are contained in Table 6, and the rainfall data, in Table 7.

TABLE 6.—*Showing the temperatures and humidity at the experimental orchard at Saigo during the experiments.*

Date.	Temperature.				Humidity.			
	Absolute maximum.	Absolute minimum.	Mean maximum.	Mean minimum.	Absolute maximum.	Absolute minimum.	Mean maximum.	Mean minimum.
June:	°C.	°C.	°C.	°C.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1 to 10	-------	-------	-------	-------	100.0	56.8	99.6	68.4
11 to 20	28.9	19.0	27.5	20.6	100.0	66.0	98.0	77.7
21 to 30	28.1	17.5	25.8	19.2	100.0	71.0	97.6	78.7
July:								
1 to 10	29.6	19.0	26.9	21.4	100.0	68.0	98.6	80.8
11 to 20	32.2	20.6	30.2	22.6	100.0	50.1	98.7	70.8
21 to 31	32.5	22.8	33.1	23.4	100.0	65.0	98.5	72.5
August:								
1 to 10	32.8	20.5	30.4	22.7	100.0	64.0	98.9	71.8
11 to 20	33.0	21.0	30.4	23.2	100.0	51.1	97.2	70.1
21 to 31	32.9	20.5	31.0	22.7	99.2	59.5	97.6	68.9
September:								
1 to 10	32.9	19.8	29.2	22.5	100.0	59.0	96.7	72.5
11 to 20	28.0	18.0	25.9	19.5	99.5	62.5	94.8	74.0
21 to 30	28.0	16.5	26.2	17.9	100.0	40.0	98.0	64.8
October:								
1 to 10	79.3	58.0	75.4	62.5	100.0	57.1	98.4	74.4
11 to 20	75.3	51.6	71.6	55.7	100.0	62.0	95.0	71.4
21 to 31	74.0	49.0	66.5	53.3	100.0	39.5	98.0	66.4
November:								
1 to 10	68.0	52.5	65.0	54.7	100.0	67.0	96.1	77.1
11 to 20	65.2	42.0	60.4	47.8	100.0	52.5	94.6	67.8
21 to 30	58.9	37.9	54.9	42.2	100.0	56.5	97.6	64.8

These tables are of interest in indicating the periods at which infection was most active. It seemed apparent, as is recorded

TABLE 7.—*Daily rainfall in millimeters at the experimental citrus orchard, Saigo, Japan, during the fruiting season of 1919.*[a]

June.			July.			August.			September.			October.			November.		
1-10	11-20	21-30	1-10	11-20	21-31	1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31	1-10	11-20	21-30
	3.0	2.2	35.0	3.2	0.0				9.7			0.5					1.1
	14.4	25.4	42.5	1.9	3.6	**5.2**		0.4	0.2				17.5				.2
	45.9		40.1	0.0	0.0	**34.1**		6.4				2.5	1.7		17.9		
		0.7	57.9	0.0	9.2	**28.4**	**1.5**		26.3	3.2		4.0			12.5	4.0	
	29.8	6.7	30.4	0.0	0.0	**1.1**	**21.2**	2.8	5.9	0.2		7.2			1.0		1.0
	12.8	11.3	17.4	0.0	0.9		**17.6**	0.1	0.2						0.1		0.1
5.0		0.3	24.2	0.0	0.0		**0.4**					0.2				11.6	
3.1	0.2	5.7	0.9	15.6	0.0				2.9						1.2	3.2	
3.7	1.3		0.0	0.0	0.0				16.9		20.9	0.2			0.1	0.8	
			2.8	0.0	0.3				0.1			0.1		4.3		0.1	
					2.5									11.4			
11.8	107.4	53.3	251.2	25.7	16.5	**68.8**	**40.7**	9.7	72.4	3.4	20.9	14.7	19.2	15.7	32.8	19.8	2.4

[a] Figures in boldface indicate periods of typhoons.

in the field notes, that in the plats sprayed with Bordeaux and Burgundy mixtures, there was little increase in canker resulting from the nyubei. Although there was a slight canker increase on the lime-sulphur plats following the nyubei, it was not extensive. Basing the spraying campaign upon the weather reports for fifteen years, collected in Nagasaki Ken, no spray applications were planned following the nyubei, in late July or early August, since typhoons usually did not occur until later. In following this plan the experiments suffered, as Tables 6 and 7 indicate. On August 2, 3, 4, and 5 a typhoon occurred, and a violent southwest wind swept the orchard, accompanied by rain. On August 14, 15, 16, and 17 another typhoon swept across southern Japan, with another rainstorm and violent southwest winds striking the orchard. Both of these typhoons occurred at a time when the trees were entirely unprotected by spray coatings. The experiments were therefore unfortunate in this one way, in that the mean seasonal conditions did not occur.

EXPERIMENTAL RESULTS

The effect of the various treatments upon the plats was measured by the number of fruits free of canker. Citrus canker except on the extremely susceptible hosts, the American grapefruit and West Indian lime varieties, is primarily a fruit blemish. The limbs and twigs are not seriously attacked, and the foliage infection is no more serious than citrus scab. By determining the number of fruits affected, therefore, the commercial value of the treatments is very closely determined. Moreover, the data thus obtained for the control plats constitute probably the most-definite measurement of the commercial losses, due to citrus canker, so far obtained.

The results from the various treatments are shown in Table 8.

From Table 8 it is evident that (*a*) all of the spray mixtures except formalin have reduced citrus-canker infection; (*b*) the Bordeaux mixtures apparently caused greatest reduction in citrus canker; there are not sufficient data to form any conclusion as to which is the better of the two mixtures employed; (*c*) Burgundy mixtures, although producing substantial reductions in the amount of canker, in no case equaled the Bordeaux mixtures in this regard; (*d*) formalin was the least effective of the sprays employed and was entirely without value; (*e*) lime sulphur reduced citrus-canker infection materially, but in no case to the extent that the copper sprays did; lime sulphur, however, had other advantages, as will be described later; (*f*) the very care-

ful pruning also materially reduced citrus canker in all cases; (*g*) the procedure which the Japanese called "rough pruning" is shown to have reduced citrus canker slightly; (*h*) the freedom from canker of the fruits on plats treated by both pruning and spraying is such as to warrant the statement that a substantial control was obtained.

TABLE 8.—*The effect of the control treatments on the presence of citrus canker.*

Plat No.	Treatment.	Fruits.	Trees.	Average fruits per tree.	Fruits free of canker.	Fruits cankered.
					Per cent.	*Per cent.*
1	Canker removed by pruning; no spraying	2,382	20	119.1	55.12	44.88
2	Canker removed by pruning; lime sulphur 1-40	2,692	21	128.1	66.59	33.41
3	Canker removed by pruning; Bordeaux mixture 4-4-50.	2,525	18	140.8	90.07	9.22
4	Canker removed by pruning; Bordeaux mixture, neutral.	1,169	16	73	93.58	6.42
5	Canker removed by pruning; Burgundy mixture.	1,712	20	85.6	81.48	18.52
6	No pruning; lime sulphur 1-40	2,668	19	140.4	22.75	77.25
7	No pruning; Bordeaux mixture 4-4-50	3,389	20	169.4	62.86	37.14
8	No pruning; Bordeaux mixture, neutral	2,963	21	140.2	65.40	34.60
9	No pruning; Burgundy mixture	3,256	20	162.8	53.40	46.60
10	No pruning; no spraying; control	4,601	22	209.3	14.17	85.83
11	No pruning; formalin 1-100	2,363	20	247.1	3.86	96.14
12	No pruning; no spraying; control	2,487	21	118.5	3.25	96.75
13	Rough pruning; Bordeaux mixture, neutral	695	9	77	70.36	29.64
14	Rough pruning; Burgundy mixture	1,224	9	136	60.38	39.62
15	Rough pruning; lime sulphur	974	10	97.4	51.75	48.25
16	Rough pruning; Bordeaux mixture 4-4-50	1,299	10	129.9	71.97	28.03
17	Rough pruning; no spraying; control	1,329	10	132.9	34.84	65.16
18	No pruning; no spraying; control	2,271	18	126.3	19.28	80.72
19	Do	524	20	26.2	7.25	92.75

In a previous paper (3) the senior writer advanced the conclusion, among others obtained by modifications of the phenol-coefficient tests, that in culture tubes copper sprays were inefficient as bactericides for *Pseudomonas citri* unless the copper precipitant was added to excess. It is interesting to observe that M. and Mme. Villedieu (6) have advanced conclusions in close agreement with this, working upon *Phytophthora infestans* in France. The present results indicate that, although copper-precipitate mixtures as used in vitro in the phenol-coefficient tests were inefficient as bactericides, the real criterion, the tests as preventives in the field, indicate that they are most effective. These peculiar results, the failure of a neutral Bordeaux mixture to exert bactericidal action in vitro while in the field it has a considerable disease-preventive action, reopen the interesting

problem as to the theory of such action. It is hoped to advance further data that will narrow the scope of this problem.

The previous conclusions advanced concerning the action of formalin solutions against *Pseudomonas citri* in vitro are entirely corroborated by the results of the present experiments. The field evidence would even support a stronger conclusion than that advanced, since trees sprayed with formalin 1 to 100 actually showed a greater percentage of canker than those untreated. This directly controverts the unfortunate recommendation of Kellerman,(2) in the Yearbook of the United States Department of Agriculture, in which he suggests formalin 1 to 100 solution as a spray in citrus-canker eradication work. Not only would such a spray be a valueless expenditure of money, but field results indicate that the canker organisms may even have been disseminated by such a spray.

The favorable bactericidal results obtained with lime sulphur in vitro are also borne out in the present field tests. However, the lime-sulphur applications, since they are easily washed off by rains, do not show the same degree of preventive action as do the copper-precipitate sprays. Lime sulphur would be the preventive spray of unquestioned desirability, if means could be obtained for retaining it on the foliage.

COSTS OF THE CONTROL MEASURES

The foregoing conclusions being advanced, the question of the costs of these methods is immediately pertinent. The costs of the operations are shown in Tables 9, 10, and 11.

TABLE 9.—*Cost of labor in spraying operations; 238 trees.*

	Yen.
First application, June 3 and 6:	
Men: $56\frac{1}{2}$ hours = $9\frac{5}{12}$ 6-hour days, at Y 1.20 per day	11.30
Work animals: $13\frac{1}{2}$ hours = $2\frac{3}{12}$ 6-hour days, at Y 3 per day	6.75
Total	18.05
Cost per tree	0.075
Second application, June 24 and 25:	
Men: 84 hours = 14 6-hour days, at Y 1.20 per day	16.80
Work animals: 14 hours = $2\frac{1}{3}$ 6-hour days, at Y 3 per day	7.00
Total	23.80
Cost per tree	0.10

TABLE 9.—*Cost of labor in spraying operations; 238 trees*—Continued.

	Yen.
Third application, August 24 and 25:	
Men: 66 hours = 11 6-hour days, at Y 1.20 per day	13.20
Work animals: 11 hours = 1⅚ 6-hour days, at Y 3 per day	5.50
Total	18.70
Cost per tree	0.06
Total cost for season	60.55
Total cost per tree for season	00.2544

The above figures include the time employed for the preparation of the spray mixtures, time lost because of unfavorable weather, and time required in repairing pump, harness, etc. The cost is representative of what would actually be the case in farm operations. Spraying in a commercial orchard, with but one mixture and without regard to plats of a limited number of trees, would undoubtedly result in lower labor costs.

TABLE 10.—*Cost of spray materials for the season.*

Plat No.	Spray used.	Quantity per plat.	Cost per plat.	Trees in plat.[a]	Cost per trees.	Remarks.
		Gals.	*Yen.*		*Yen.*	
1	No spray	--------	--------	22	--------	
2	Lime sulphur 1-40	80	1.10	22	0.05	Trees smaller than average in orchard.
3	Bordeaux 4-4-50	80	1.54	22	0.07	Do.
4	Bordeaux neutral	65.5	1.12	22	0.051	Do.
5	Burgundy	82.5	1.57	22	0.071	
6	Lime sulphur	87.5	1.20	22	0.055	
7	Bordeaux 4-4-50	92.5	1.78	22	0.081	Rather large trees above average in orchard.
8	Bordeaux neutral	105	1.81	22	0.082	Do.
9	Burgundy	85	1.51	22	0.069	Do.
10	No treatment	--------	--------	22	--------	Do.
11	Formalin 1-100	70	16.38	22	0.745	
12	No treatment	--------	--------	22	--------	
13	Bordeaux neutral	29.5	0.52	10	0.052	
14	Burgundy	37.5	0.67	10	0.067	
15	Lime sulphur 1-40	37.5	0.52	10	0.052	
16	Bordeaux 4-4-50	42.5	0.82	10	0.082	
17	No spray	--------	--------	10	--------	
18	No treatment	--------	--------	10	--------	
19	Do	--------	--------	10	--------	

[a] A number of these trees were Unshiu (Satsuma) or Valencia orange trees. Although fruits from these plats did not enter into the experimental data, they were nevertheless sprayed in passing down the orchard rows; their number therefore is necessarily included in estimating the cost of the spraying operations.

TABLE 11.—*Total cost of control measures in each plat calculated per tree.*

Plat No.	Treatment.	Pruning (from Table 3).	Spray materials, 3 sprays.	Labor for spraying.	Total.
		Sen.	*Sen.*	*Sen.*	*Sen.*
1	Removal of sources of infection only	59.6			59.6
2	Infection sources removed; lime sulphur 1-40, 3 sprays	59.6	05.0	25.5	90.1
3	Infection sources removed; Bordeaux 4-4-50, 3 sprays	59.6	07.0	25.5	92.1
4	Infection sources removed; neutral Bordeaux, 3 sprays	59.6	05.1	25.5	90.2
5	Infection sources removed; Burgundy 3-3-50, 3 sprays	59.6	07.1	25.5	92.2
6	3 sprays, lime sulphur 1-40		05.5	25.5	31.0
7	3 sprays, Bordeaux 4-4-50		08.1	25.5	33.6
8	3 sprays, Bordeaux neutral		08.2	25.5	33.7
9	3 sprays, Burgundy 3-3-50		06.9	25.5	32.4
10	No treatment				
11	3 sprays, formalin 1-100		74.5	25.5	100.0
12	No treatment				
13	Pruning to remove infection sources; 3 sprays, Bordeaux neutral.	10.4	05.2	25.5	41.1
14	Pruning to remove infection sources; 3 sprays, Burgundy 3-3-50.	10.4	06.7	25.5	42.6
15	Pruning to remove infection sources; 3 sprays, lime sulphur 1-40.	10.4	05.2	25.5	41.1
16	Pruning to remove infection sources; 3 sprays, Bordeaux 4-4-50.	10.4	08.2	25.5	44.1
17	Pruning to remove infection sources; no other treatment	10.4			10.4
18	No treatment				
19	Do				

For the purpose of aiding those who wish to convert these costs into terms of American currency, the following comments are necessary:

The Japanese yen varies in value but is usually nearly equivalent to 50 cents United States currency; the sen is 0.5 cent United States currency. Japanese labor is not so efficient as American labor; it required five men to operate a hand-power spray pump with two lines of hose, which would be operated by three men in America. The Japanese laborers worked only six hours a day, whereas an American farm laborer would work at least eight, and more often nine or ten hours a day. A sled drawn by a cow was used as a conveyance for the spray pump; horses were not available. For the hire of the cow, 3 yen was paid for a six-hour day. This mode of conveyance was, moreover, extremely slow. The cost of spray materials in Japan is as high as, or probably in most cases higher than, the same supplies at most points in America. Those interested can, therefore,

compare for themselves the costs of spraying in Japan with those in America; the disadvantage to American conditions, if it exists at all, is very slight.

To summarize, then, a reduction from 80 to 96 per cent of cankered fruits on untreated plats, to 6.5 per cent on plat 3, cost 92.1 sen or 46 American cents per tree. This included very careful pruning of the trees. A reduction from 80 to 96 per cent to 34.5 per cent was obtained without pruning for 33.7 sen or, roughly, 17 American cents per tree. Formalin 1 to 100 solution, the least-effective spray, was incidentally by far the most expensive. The figures are presented in detail here and probably can be best interpreted for each country by those men in the industry closely acquainted with the markets. In America, however, with the highly developed competition for markets, this reduction of the blemish caused by canker would apparently be profitable at these costs. In oriental countries, where a blemish upon the fruit is not so important, possibly the expenditure for control would not be advantageous. These statements apply only to that class of citrus fruits having the susceptibility of the Washington navel.

It should be considered that there are factors which made these results less profitable than would be the case in ordinary years. First, the typhoons which occurred in early August are unusual in normal years. These typhoons were entirely unexpected, and the trees were entirely unprotected by preventive-spray coatings. One typhoon at this time would have been a considerable setback, but a second one is far from a normal seasonal occurrence. Another factor has been pointed out previously; namely, that continued spraying, year after year, would materially reduce the sources of infection, so that canker control should more nearly approach completeness with successive years. The results presented here, being those of the first year of control attempts, are not so favorable as they would be in a succeeding year.

RELATION OF WIND PREVENTION TO CANKER CONTROL

Another factor, that of protection against winds, could be improved upon in commercial work over that in the experiments. Although a row of a coniferous tree surrounded the orchard, such a windbreak was small and not sufficient to protect the whole orchard; a much more desirable condition could be provided. The data available to show the definite value of windbreaks follow:

A row of loquat trees ran across the experimental orchard from east to west. The situation of these loquat trees is shown

in fig. 1. These trees were not high, but afforded protection from the southwest typhoon winds to the citrus trees immediately adjacent to the north. The percentage of cankered fruits on these rows north of the windbreak is shown in Table 12.

TABLE 12.—*Showing the relation of windbreaks to the occurrence of citrus canker.*

Row, numbered from windbreak outward.	Total fruits.	Cankered fruits.	
		Number.	*Per cent.*
1	2,220	131	5.90
2	2,718	531	19.53
3	2,523	934	37.01
4	2,929	1,210	41.31
5	2,103	1,134	53.92
6	2,073	1,253	60.44
7	2,218	1,331	60.00
8	2,711	1,496	55.18
9	2,236	1,098	49.10
10	1,820	967	53.13

Row 1 was nearest to the windbreak, while the height of the windbreak, perhaps at most 6 meters, was not sufficient to protect the trees in rows 4 to 10. It is evident from this that much can be done to reduce canker infection by (*a*) location of the orchard to avoid such violent winds as may occur in seasonable periods favorable for canker development, and (*b*) the use of high, thick windbreaks. These conclusions have been corroborated repeatedly by field observations.

INFLUENCE OF COPPER SPRAYS UPON THE QUALITY OF THE FRUITS

Although canker was materially reduced by the copper sprays in these experiments, there were considerable disadvantages, evident at harvesting time, following the use of such sprays. These were an increase in red-spider infestation on sprayed trees, an increase of sooty mold, *Meliola cameliae*, upon the fruits, and an increase of melanose. The occurrence of these diseases upon the plats is shown in Table 13.

Table 13 shows very little sooty mold for unsprayed plats and for plats sprayed with lime sulphur and formalin. Plats sprayed with the copper mixtures show an increase to as high as 24 per cent of fruits affected with sooty mold; there is no evidence from this table that any one of the copper sprays is less serious in this respect than the others. The explanation generally accepted for such an increase of sooty mold following

fungicide applications is that fungi, parasitic upon injurious insects, are killed by the spray applications. The insects, when not limited by the parasitic fungi, increase enormously, and such species as secrete honey dew are then followed by sooty mold.

TABLE 13.—*Showing the results of the spray applications in increasing other diseases.*

Plat No.	Spray mixture employed.	Affected fruits.		Red-spider affection of fruits.
		Sooty mold.	Melanose.	
		Per cent.	*Per cent.*	
1	Canker removed by pruning; no spraying	0.75	----------	None.
2	Canker removed by pruning; lime sulphur 1-40	1.37	4.04	Do.
3	Canker removed by pruning; Bordeaux mixture 4-4-50	9.85	42.59	All fruits.
4	Canker removed by pruning; Bordeaux mixture neutral.	10.35	63.38	Do.
5	Canker removed by pruning; Burgundy mixture	4.20	61.03	Do.
6	No pruning; lime sulphur 1-40	0.59	0.59	Do.
7	No pruning; Bordeaux mixture 4-4-50	14.60	37.65	Do.
8	No pruning; Bordeaux mixture neutral	7.79	54.43	Do.
9	No pruning; Burgundy mixture	4.94	41.86	Do.
10	No pruning; no spraying; control	1.49	2.32	Very little.
11	No pruning; formalin 1-100	0.50	----------	None.
12	No pruning; no spraying; control	0.20	0.40	Do.
13	Rough pruning; Bordeaux mixture neutral	2.58	61.15	All fruits.
14	Rough pruning; Burgundy mixture	2.85	53.26	Do.
15	Rough pruning; lime sulphur	0.82	2.15	Do.
16	Rough pruning; Bordeaux mixture 4-4-50	24.94	38.79	Do.
17	Rough pruning; no spraying; control	2.18	4.13	Very little.
18	No pruning; no spraying; control	1.14	1.36	None.
19	Do	0.38	0.76	Do.

An unexpected development was the increase in blemish upon the fruits which was identical in appearance with the melanose injury due to *Phomopsis citri* Fawcett. The increase of a fungus disease with no insect relationships, following the application of fungicides, is notably peculiar. In this csae a greater percentage of fruits affected with melanose is quite definitely correlated with the neutral Bordeaux mixture applications. Burgundy mixture was somewhat less injurious, while Bordeaux 4–4–50 mixture was the least injurious of the copper sprays. Lime-sulphur and formalin applications resulted in little or none of this blemish. No attempt will be made to put forward an explanation for this; it is sufficient to call attention to this fact: that a blemish similar to melanose increased following applications of the copper-precipitate mixtures.

The third striking feature, very noticeable on the spray plats, was the increase of red spider following the applications of the

copper-precipitate mixtures. This increase of red spider was noticeably slight or absent from the lime-sulphur, formalin, and unsprayed plats.

The injury resulting from the red spider, melanose, and sooty-mold blemishes very largely depreciated the commercial value of the favorable results in the reduction of citrus-canker infections. However, the increase in sooty mold and red spider may be readily avoided by the addition of oil emulsions to the copper-precipitate sprays. In fact, it was through a misunderstanding between the writers that an insecticide was not added to the spray mixtures in August. It is suggested also that it might be desirable to spray with one of the copper sprays in June and July, and change to lime sulphur in August. A very noticeable result from the experiments, and one which elicited considerable favorable comment from the growers, was the luxuriant green of the foliage and the clear, flawless color of the fruits of the lime-sulphur plats. It would seem desirable, therefore, for future investigators to attempt a schedule of copper-precipitate sprays during the early part of the rainy period, changing to lime sulphur as the rains become less. Another suggestion for future experiments is that lime sulphur be employed at more frequent intervals. The control of sooty mold and red spider is so simple that these deleterious results scarcely need be considered as affecting the experimental value of the results showing canker reduction.

Following the use of the sprays employed in these experiments there was no noticeable insipidity or reduction of acidity of the fruits, such as has been described by Gray and Ryan (1) following lead arsenate sprays.

EFFECTS OF CITRUS CANKER UPON THE WASHINGTON NAVEL ORANGE

In the literature on citrus canker in America, very little has been stated as to the injuries resulting from the disease. This has been primarily because of the eradication work which has made continued observations upon commercial citrus plantings impossible. For a satisfactory understanding of the present control data it seems advisable to state briefly the effects of citrus canker in Nagasaki Prefecture, Japan.

Citrus canker affects the foliage and fruits of the Washington navel orange; twigs are rarely attacked and the mature wood is not commonly affected, as is the case with the very susceptible varieties of West Indian limes and American grape fruits.

Upon the foliage of the Washington navel, citrus canker must effect some reduction in the amount of leaf surface capable of functioning. An estimate of such injury is of course difficult but, to offer a comparison, it is somewhat similar to the effect of shot-hole disease of the apricot, or such similar leaf-spot diseases on the apple or the pear. Citrus canker, moreover, must shorten to some extent the life of an affected leaf, for such affected leaves are the first to drop on the occurrence of any slight stimulus, as a brisk shower or a strong spray application (see Plate 2, fig. 1).

The losses due to citrus canker upon the Washington navel, which would be most appreciated by the growers, are due to infections upon the fruits. A dropping of the fruits, infected while they were small, was observed upon the formalin plat and the untreated plats of these experiments. This is rather poorly shown in the photograph in Plate 2, fig. 2. This dropping of the fruits did not occur upon the treated plats lying adjacent, so that it is reasonable to assume that this fruit drop was due to the canker infections, and not to drought or other nutrition causes. The fruit drop due to canker was not sufficiently extensive to be appreciated by the commercial growers.

Secondly, the fruits if infected when larger, although they do not fall, are more or less blemished. In Japan this is not a serious handicap. In fact, infected fruits matured earlier than uninfected fruits, and the orchard coolies in selecting oranges for eating would choose those badly cankered, stating that they were sweeter.

In the United States, however, where marketing is considerably more advanced, the blemish due to canker would presumably necessitate lower prices for infected fruits. It is very difficult to state such losses except possibly by comparison. The blemish due to canker would be similar to peach scab or pear scab, but probably more abundant. Table 8 shows that blemished fruits due to citrus canker amounted to from 80 to 96 per cent upon untreated plats; this is of course a serious proportion. Such blemishes are shown in Plate 3, and an idea of the effect of these fruits in the market can be best obtained by those more familiar with market conditions.

Another loss, very difficult to appreciate, but fortunately apparent from the present experimental results, is due to a reduction in weight of fruits affected with canker. This is shown in Table 14.

This table shows an average loss in weight obtained from 40,523 fruits, of 0.2 gram per cankered fruit. This amount

is so small as to be considered negligible by many, yet in large orchards could amount to a tangible loss.

TABLE 14.—*Showing the weight of cankered fruits as compared with that of normal fruits.*

Plat No.	All fruits.			Canker-free fruits.			Cankered fruits.		
	Number.	Total weight.	Average weight.	Number.	Total weight.	Average weight.	Number.	Total weight.	Average weight.
		Kilos.	*Kilo.*		*Kilos.*	*Kilo.*		*Kilos.*	*Kilo.*
1	2,382	416.40	0.1742	1,313	232.40	0.1770	1,069	184.00	0.1720
2	2,692	471.35	0.1743	1,893	341.80	0.1805	799	129.55	0.1621
3	2,525	310.00	0.1227	2,292	274.70	0.1198	233	35.30	0.1515
4	1,169	189.40	0.1620	1,094	180.00	0.1645	75	9.40	0.1253
5	1,712	298.25	0.1742	1,395	247.10	0.1771	317	51.15	0.1613
6	2,668	457.20	0.1713	607	106.35	0.1752	2,061	350.85	0.1702
7	3,389	631.95	0.1864	2,130	403.85	0.1896	1,259	228.10	0.1811
8	2,963	514.15	0.1735	1,938	347.40	0.1792	1,025	166.75	0.1626
9	3,256	573.80	0.1762	1,739	322.90	0.1856	1,517	250.90	0.1653
10	4,601	796.50	0.1731	652	116.10	0.1780	3,949	680.40	0.1723
11	2,363	419.10	0.1773	91	12.30	0.1340	2,272	406.80	0.1789
12	2,487	441.15	0.1773	81	14.80	0.1827	2,406	426.35	0.1772
13	695	120.50	0.1773	489	86.05	0.1759	206	34.45	0.1672
14	1,224	212.40	0.1735	739	126.25	0.1708	485	86.15	0.1776
15	974	175.40	0.1800	504	91.90	0.1823	470	83.50	0.1776
16	1,299	228.90	0.1762	935	163.90	0.1752	364	65.00	0.1785
17	1,329	243.10	0.1829	453	87.30	0.1927	876	155.80	0.1778
18	2,271	404.10	0.1778	438	80.60	0.1840	1,833	323.50	0.1764
19	524	69.15	0.1319	38	4.85	0.1276	486	64.30	0.1323
Total	40,523	6,972.80	0.1720	18,821	3,240.55	0.1721	21,702	3,732.25	0.1719

Data concerning a possible loss in the number of fruits are available from Table 8; although varying orchard conditions affect these data, Table 8 shows no loss upon untreated plats as compared with treated plats. Nevertheless, the observations made in the early part of the spraying season, which recorded a fruit drop, indicate that there must be some loss in the number of fruits due to canker, although it is so small as not to be apparent at the end of the season.

Fruits affected with canker sometimes crack and split, but fruits whose surfaces are normal frequently do this also. However, cases have been seen where such splitting is very closely connected with the canker lesions. Two such cases are shown in Plate 4, fig. 1. Another injury due to canker, but seen very infrequently, is the infection with fruit-rot organisms, following citrus-canker lesions. Such cases are not at all common, however. Rot following a canker infection is shown in Plate 4, fig. 2.

These statements and figures of course apply only to the Washington navels, and varieties of similar susceptibility, such

as the oranges of Florida origin and some of the East Indian pummelos. The grapefruits and West Indian limes are affected much more seriously, both on the foliage and on the fruits. The Satsumas, Valencias, and mandarin oranges are not so severely affected.

To summarize, the injury to Washington navels caused by citrus canker is due to: (*a*) An indeterminable loss, due to a decrease in the functioning of infected leaves; (*b*) a scarcely appreciable loss, due to the dropping of fruits affected when young; (*c*) a loss in marketing, due to the blemish on affected fruits; (*d*) a slight loss in weight of cankered fruits; and (*e*) occasional secondary infection with fruit rots, following canker infection.

APPLICATION OF RESULTS

The reduction in amounts of canker recorded here on the Washington navel warrants the statement that a control for this disease is possible for hosts of this class of susceptibility and for less-susceptible species and varieties. Such a control appears to be feasible from a standpoint of costs. For commercial use it is recommended that Bordeaux 4–4–50 be used in periods of wet weather, while a change to lime sulphur should be made in periods of little rainfall. The utmost precaution is necessary to avoid increases in insects following copper sprays; for this reason an oil emulsion or other scalecide should be added to the Bordeaux mixture, probably with every application.

In the southern United States, where eradication work is still in progress, the use of preventive sprays, such as Bordeaux mixture with an oil emulsion, for trees adjacent to an infected tree will obviously reduce the chances for the spread of infection. In the past, formalin solutions have been frequently used; such solutions not only are more expensive but, at concentrations not injurious to the trees, also have no bactericidal or preventive value.

It also seems reasonable to suppose that lime-sulphur and Bordeaux-mixture applications, made for the prevention of citrus scab and other diseases, will greatly lessen the chances for canker infection.

The spraying schedule used for these experiments in Nagasaki Prefecture apparently requires slight changes. The application made on August 24 could be advanced to August 15, apparently with better results. Should the results warrant, two applications could be made during the typhoon period, in August and September. These statements of course apply only to Nagasaki

Prefecture. For other countries, in which canker is widespread, a spraying schedule should be worked out to agree with the climatic peculiarities of each region.

SUMMARY

1. Experimental work on the prevention of citrus canker upon trees of the Washington navel variety of the sweet orange, *Citrus sinensis,* is described.

2. The following results were obtained by these methods: Copper sprays without other treatment reduced the number of fruits affected with citrus canker to as low as 34, 37, and 46 per cent. Untreated plats had percentages of cankered fruits of 80, 86, 92, and 96 per cent. The cost of these spray applications for the season was from 32.4 to 33.7 Japanese sen per tree.

3. Lime sulphur without other treatment reduced canker, but not to such an extent as did the copper sprays. The applications of this spray for the season cost 31 Japanese sen per tree.

4. Formalin 1 to 100 solution did not reduce canker. On the contrary, the trees sprayed with formalin had a very slightly larger percentage of cankered fruits than did the controls. The cost of formalin sprays for the season was 1 Japanese yen per tree, or three times the cost of any of the other sprays.

5. Spraying with copper sprays, accompanied by a removal of the sources of infection before the period of canker activity, reduced the canker percentage on treated plats to 9.25 per cent, 6.5 per cent, and 18.5 per cent. The cost of such treatments was 92 sen for Bordeaux 4–4–50 mixture, 90 sen for neutral Bordeaux mixture, and 92 sen for Burgundy 3–3–50 mixture.

6. The trees treated for the removal of sources of infection, without other treatment, showed a reduction to 45 per cent of fruits cankered, at a cost per tree of 59.6 sen. Comments showing the comparative labor efficiency in Japan and America are made, which show that American orchard labor is but slightly more expensive than Japanese, if at all.

7. Data are presented to show that wind prevention in itself may reduce citrus-canker development from 50 to 60 per cent to 6, 20, and 37 per cent. This is also corroborated by numerous field observations.

8. Data were obtained from the spraying experiments which showed an increase to as high as 25 per cent of sooty mold, 63 per cent melanose, and 100 per cent red spider following the copper sprays. The percentages on untreated plats were less than 3 for sooty mold, and 5 for melanose, and there was no red

spider. There were slight increases in these troubles following the lime sulphur applications.

9. The injury of citrus canker to the Washington navel orange is described in detail, and consists of an indeterminable loss to the tree due to a slight reduction in functioning leaf surface, a slight loss due to dropping of fruits infected when young, the loss due to reduction in market value resulting from the blemish on fruits when cankered, a slight reduction in weight of affected fruits, and an infrequent secondary infection with fruit rots following canker infection. These statements do not apply to the more-susceptible limes and grapefruits nor to the less-susceptible Mediterranean sweet oranges, Satsuma oranges, lemons, mandarin oranges, calamondins, kumquats, or citrons.

10. It seems reasonable to conclude that, in countries where citrus canker is already widespread or universal, a feasible control may be obtained upon citrus fruits of the general susceptibility of the Washington navel. In regions such as Florida and the Gulf States of America, where an attempt is being made to eradicate the disease entirely, preventive sprays would materially lessen the chances for infection. Formalin 1 to 100, recommended by Kellerman for this use, is here shown to be entirely valueless as a preventive and, previously, as a bactericide; it is moreover three times as expensive as a copper spray. Lime sulphur, or Bordeaux mixtures with an oil emulsion, from these experiments, would seem to be the preventive sprays most effective for this use.

REFERENCES

1. GRAY, GEO. P., and RYAN, H. J. Reduced acidity caused by certain sprays. Mo. Bull. Dept. Agr. California, No. 1, 10 (January, 1921) 11.
2. KELLERMAN, KARL F. Cooperative work for eradicating citrus canker. Yearbook of the U. S. Dept. Agr. (1916) 270.
3. LEE, H. ATHERTON. Action of some fungicides on the citrus-canker organism. Philip. Journ. Sci. **17** (1920) 325.
4. LEE, H. ATHERTON. Citrus-canker control, a progress report of experiments. Philip. Journ. Sci. **19** (1921) 129.
5. PELTIER, GEORGE L. Influence of temperature and humidity on the growth of Pseudomonas citri and its host plants and on infection and development of the disease. Journ. Agr. Res. **20** (1920) 447.
6. VILLEDIEU G., M. and MME. De la non-toxicité du cuivre pour le mildiou. Compt. Rend. Acad. Sci. **172** (1921) 335.
7. WINSTON, J. R., and FULTON, H. R. The field testing of copper-spray coatings. Bull. U. S. Dept. Agr. **785** (1919) professional paper.

ILLUSTRATIONS

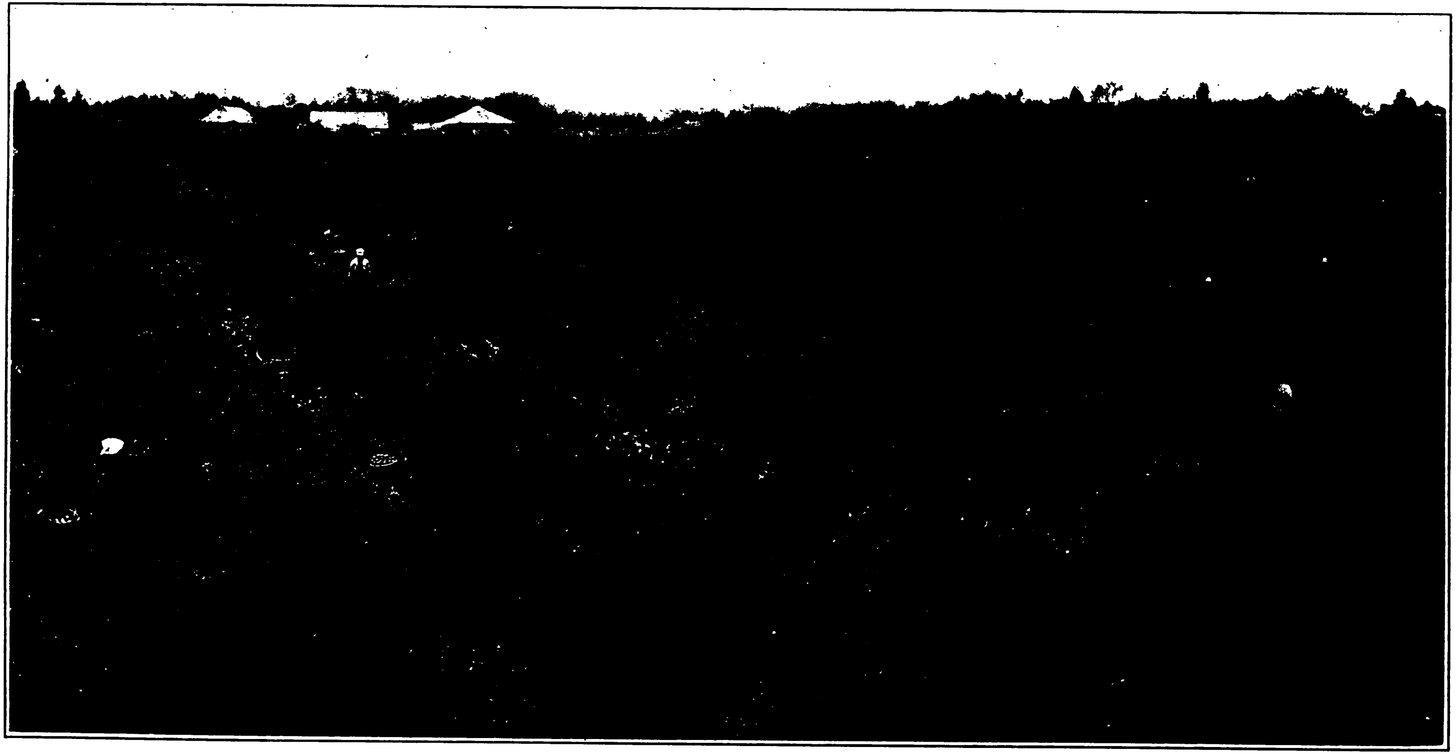


PLATE 1. CHARACTER OF THE EXPERIMENTAL ORCHARD AT SAIGOMURA, NAGASAKI PREFECTURE, JAPAN.

Fig. 1. Leaves affected with citrus canker fallen to the ground after a brisk shower.

Fig 2. Showing fruit drop of Washington navels due to canker. The cankers may be seen on some of the fallen fruits.

PLATE 2.

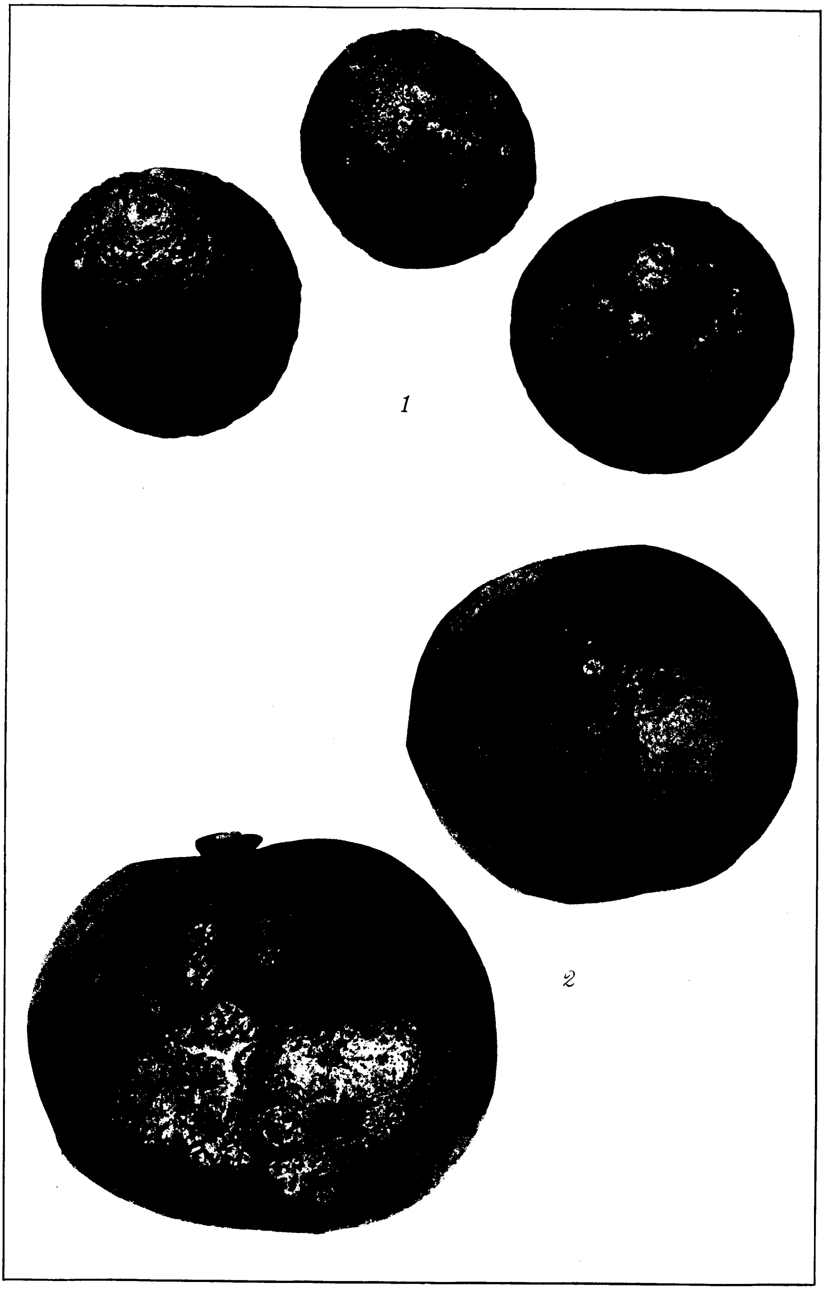


Fig. 1. Fruits of Washington navel with citrus canker, showing injury to appearance. 2. Showing ill-looking scars on Washington navel fruits, due to citrus canker. The fruit to the left shows the skin beginning to crack.

PLATE 3.

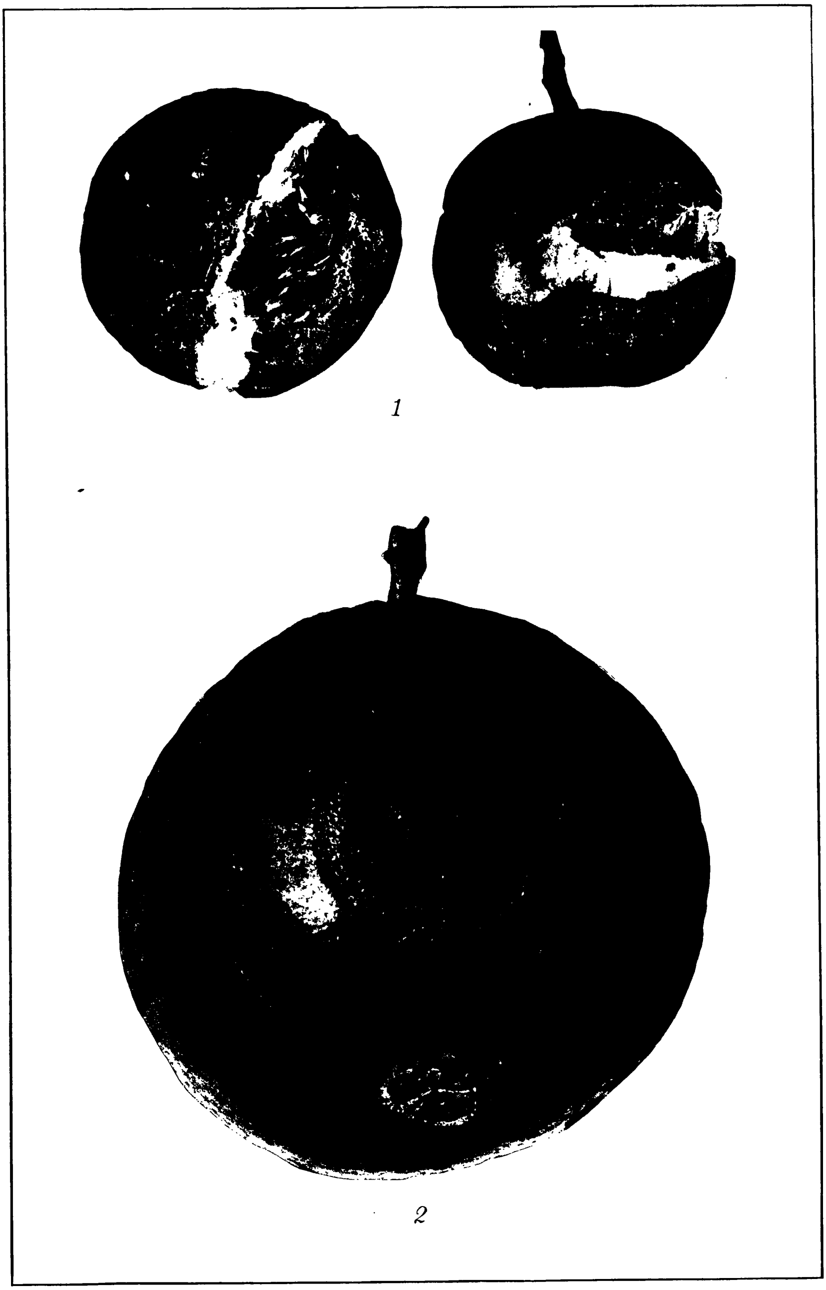


Fig. 1. Cracking of young Washington navel fruits, apparently connected with the canker lesions on the skin. 2. Secondary fruit rot on Washington navel following citrus-canker infection. This injury was very infrequent.

PLATE 4.

NEUE BRENTHIDEN VON DEN PHILIPPINEN UND BORNEO

Von R. KLEINE

Stettin, Germany

EINE TAFEL

Das von Herrn Prof. C. F. Baker gesammelte Käfermaterial der Philippinen und von Sandakan hat mir, soweit die Brenthidae in Frage kommen, durch die Liebenswürdigkeit Prof. Dr. Hellers zu Dresden vorgelegen. Sämtliche Typen sind im Dresdener Museum.

NEUE ARTEN VON DEN PHILIPPINEN

TRACHELIZINI

Cerobates costatus sp. nov.

Männchen.—Rotbraun, die postmediane Makel auf den Elytren undeutlich, Schenkel und Schienen an Basis und Spitze schwach verdunkelt.

Kopf hinter den Augen gerundet, Raum zwischen dem hinteren Augenrand und dem Hals etwa die Hälfte des Augendurchmessers. Oberseite platt, über den Hals vorgezogen, dreieckig eingekerbt, ungefurcht, zwischen den Augen eine elliptische Grube, überall einzeln, zart punktiert. Kopfseiten ohne Skulptur; Unterseite unter den Augen mit einzelnen Härchen.

Metarostrum ungefurcht, rundlich, Meso- und Prorostrum abgeplattet mit schwachem Mittelkiel. Metarostrum auf der Unterseite in einer grossen tiefen Grube endigend, Mesorostrum erweitert und in üblicher Weise einzeln grob punktiert.

Fühler bis über den Prothorax reichend, das erste Glied gross, walzig; das zweite kegelig, das kürzeste von allen; 3 bis 10 gleichlang, konischkegelig, vordere Glieder etwas schlanker, das elfte elliptisch etwas verlängert, alle Glieder zart und lang behaart.

Prothorax in der hinteren Hälfte deutlich gefurcht, vor dem Halse mit kleiner Grube, Punktierung einzeln, zerstreut, zart; Seiten und das Prosternum matt, ohne Skulptur.

Elytren mit durchgehenden Rippen und Furchen, alle Rippen bis auf den Aussenrand voll entwickelt, die zweite auf der Mitte verschmälert, die fünfte scharf gekielt; alle Rippen einzeln punktiert.

Metasternum und Abdominalsegmente 1 und 2 breit und flach gefurcht, zart punktiert, das vierte Segment schmäler als das dritte, das fünfte nur an der Basis glatt, sonst, namentlich am Hinterrand, dicht punktiert.

Länge, total, 5.5 millimeter; Breite, Thorax, 0.75 circa.

MINDANAO, Surigao.

In Sennas *Cerobates*-Tabelle [1] kommt man zu A. A., hh, Seite 215, wo *C. grouvellei* Senna und *birmanicus* Senna hingehören. Letztere Art scheidet von vornherein aus, es kann also nur *grouvellei,* die auch auf den Philippinen lebt, in Frage kommen. *C. costatus* wird durch folgende Merkmale getrennt: Kopf nach hinten über den Hals gezogen. Rostrum gänzlich ungefurcht. Metarostrum unterseits in einer grossen grubenartigen Aushöhlung endigend. Elytren mit vollentwickelten, starken Rippen versehen.

Die Verwandtschaft mit den obengenannten Arten ist aber sehr gross.

Miolispa persimilis sp. nov.

Männchen.—Kopf, Rüssel, und Prothorax grünlich erzfarben, Elytren schwärzlich braun, die dritte Rippe gelb, Unterseite rotbraun, Beine desgleichen, Schenkel und Schienen an Basis und Spitze und die Tarsen verdunkelt; am ganzen Körper hochglänzend.

Kopf mehr oder weniger gewölbt, ungefurcht, am Hinterrand tief dreieckig eingeschnitten, zwischen den Augen gefurcht, überall einzeln kräftig, zerstreut punktiert. Seitliche Einkerbungen des Hinterrandes viel kleiner als oberseits, Punktierung dichter als auf der Oberseite. Unterseite nur ganz zerstreut punktiert.

Metarostrum bedeutend kürzer als das Prorostrum, dreifurchig, Furchen etwa gleich breit, matt chagriniert, Mittelfurche als Fortsetzung der Kopffurche; Unterseite gerundet. Mesorostrum etwas erweitert, platt, Mittelfurche kaum verengt, Punktierung soweit vorhanden, kräftig; Unterseite flach gekielt. Prorostrum nach vorn allmählich breiter und platter werdend, Vorderrand rundlich, kurz eingebuchtet, Mittelfurche bis ein

[1] Notes Leyden Mus. 17 (1895) 209 ff.

Drittel der Länge kräftig, tief, Punktierung überall kräftig und ziemlich dicht; Unterseite am Mesorostrum gekielt.

Fühler robust, das erste Glied gross, das zweite ohne Stiel, breiter als lang, das dritte kegelig, länger als breit, 4 bis 8 breiter als lang, vom sechsten ab scharfkantig, das neunte und zehnte grösser aber breiter als lang, das elfte stumpf-konisch, basale Hälfte fast ohne Beborstung, dann zunehmend, 9 bis 11 dicht beborstet.

Prothorax eiförmig, am Halse stärker verengt als am Hinterrande, grösste Ausdehnung hinter der Mitte, Hinterrand schmal, scharf. Oberseite tief durchgehend gefurcht, rugos, einzeln punktiert. Nach dem Hals nimmt die Punktierung ab. Seiten zart punktiert, Unterseite fast ohne Skulptur.

Elytren an der Basis nach innen gebogen, Humerus spitz, Seiten parallel, nach dem Absturz verschmälert, hinten flach dreieckig eingeschnitten, Aussenecken stumpflich, rundlich, erste und zweite Rippe flach und breit, dritte breiter aber gewölbt, die folgenden schmal, konvex, erste, zweite, sechste, und achte bis auf den Absturz reichend, alle Rippen punktiert, die sechste mit drei starken, grossen, punktartigen Eindrücken, zwei an der Basis, eine auf der Mitte. Suturalfurche unpunktiert, die erste deutlich punktiert, von der zweiten an gitterfurchig.

Beine wie bei *M. novaeguineensis* Guér.

Metasternum nur an der Basis gefurcht, überall zart, zerstreut punktiert, an den Seiten etwas kräftiger, das erste und das zweite Abdominalsegment breit und tief gefurcht, Punktierung kräftig, Quernaht zwischen den Segmenten undeutlich, das dritte Segment etwas breiter als das vierte, an den Seiten und am Hinterrande dicht punktiert und zum Teil eng behaart.

Parameren mittellang, Lamellen fingerförmig, schwach aber lang behaart, Pigmentierung nur im vorderen Teil dunkler. Penis im Präputialteil schwach verengt, fast ganz hyalin, vorn zugespitzt, Pigmentierung dortselbst an den Seiten stark, braun.

Länge, total, 9.5 Millimeter; Breite, Thorax, 1.5.

MINDANAO, Kolambugan.

Die neue Art ist sehr nahe mit *M. novaeguineensis* verwandt und sicher auf den Philippinen Vicariante desselben. Unter allen Umständen trennen die Verschieden geformten Begattungsorgane sicher und einfach. Als äussere Erkennungsmerkmale sind zu nennen: Kopf am Halse nicht verjüngt, ohne Mittelfurche, Metarostrum nicht sammetartig und matt. Die sechste Rippe erreicht den Absturz und trägt drei Punkte statt nur einen. Metasternum schwach punktiert. Ferner besteht Aehnlichkeit

mit *M. mariae* Senna. Der Kopf ist dort auch gefurcht. Zwischen den Augen ist der Kopf dreifurchig, die seitlichen Einkerbungen sind grösser als die oberseitigen. Meta- und Prorostrum sind gleichlang. Die Fühlerglieder sind von anderer Form. Die Unterseite ist anders skulptiert.

Die drei Arten sind also hinreichend verschieden, sie stellen aber einen gemeinsamen Habitus dar, der aus dem asiatischen Gebiet bis Neu-Pommern zu verfolgen ist.

Hypomiolispa tomentosa sp. nov.

Weibchen.—Von gedrungener Gestalt, schmutzig ziegelrot, Spitze des Metarostrums, Halsring und Hinterrand des Prothorax, Sutura, eine postmediane Makel, der äusserste Seitenrand der Decken und die Beine in üblicher Weise schwarz.

Kopf (ohne Augen) länger als breit, Mittelfurche bis zur Augenmitte schmal, dann breit, dreieckig erweitert, Punktierung einzeln und grob, Oberseite und Seiten tomentiert, Unterseite neben den Augen punktiert, in den Punkten wie auch oberseits, behaart und tomentiert, eine flache Mittelfurche ist ohne Toment. Augen sehr gross, den ganzen seitlichen Kopf einnehmend, prominent. Der hintere Augenrand nicht gekerbt.

Metarostrum so breit wie der Kopf, gefurcht, Mesorostrum nur wenig erweitert und schmal gefurcht, die Furche bis auf das Prorostrum reichend. So weit sich die Furchung erstreckt, sind Kopf und Rüssel matt und tomentiert, Prorostrum glänzend.

Fühlerglieder 2 bis 8 quer, das neunte und zehnte mehr oder weniger kugelig, das elfte stumpfspitzig, alle Glieder locker gestellt und kräftig behaart.

Prothorax kräftig längsgefurcht und sehr grob rugos punktiert, nach dem Halse zu lässt die Punktierung nach, reicht seitlich aber bis zu den Hüften. Prosternum vor den Hüftringen mit einer Reihe grober Punkte. Elytren ohne besondere Merkmale.

Beine von normaler Gestalt, alle Schenkel an der Basis matt, sonst glänzend, unterseits mit einem sich über den ganzen Stiel bis zur Keule hinziehenden Toment.

Metasternum nur an der Basis, Abdomen nicht gefurcht. Rugose Punktierung des Metasternums stark und gross, auf dem ersten und zweiten Abdominalsegment schwächer, nach dem dritten zu ganz verschwindend, 3 bis 5 ohne Skulptur, hochglänzend, an den Seiten dicht filzig behaart.

Länge, total, 9.5 Millimeter; Breite, Thorax, 2.

MINDANAO, Iligan.

Die neue Art gehört in die erste Gruppe meiner Bestimmungstabelle [2] und ist durch den starken Toment auf Kopf, Rüssel, und den Schenkelunterkanten mit *H. exarata* Desbr. verwandt aber sehr leicht zu trennen, da die bei *exarata* an der Körperseite stark entwickelten Tomentstellen fehlen.

BELOPHERINI

Genus **YPSELOGONIA** novum

Weibchen.—Kopf fast quadratisch, nach den Augen etwas verengt, Hinterrand gerade, Hinterwinkel gerundet, Oberseite mässig gewölbt, Mittelfurche fehlend oder doch höchstens ganz obsolet, zwischen den Augen bestimmt flach gefurcht; Unterseite ohne Gularfurche, gewölbt, ohne Furche oder Kiel, warzig skulptiert. Augen mittlerer Stärke, hemisphärisch, in drei Viertel Augendurchmesser vom Hinterrand des Kopfes entfernt.

Metarostrum kürzer als der Kopf, rundlich, nach dem Mesorostrum zu verengt, Mittelfurche am Kopf breit angesetzt, nach vorn keilförmig verschmälert; Mesorostrum erweitert, schwach gewölbt, undeutlich schmal gefurcht, Unterseite mit einem starken, nach vorn-unten gerichteten, gekrümmten Zahn, der auf einer bis auf das Mesorostrum reichenden Leiste aufsitzt. Prorostrum drehrund.

Fühler sehr lang, fast von Körperlänge, das erste Glied lang, walzig, nach vorn verdickt, das zweite am kürzesten, kegelig, das dritte länger aber kürzer als die Folgenden, 4 bis 8 etwa gleichlang, schlank, vorn schwach verdickt, das neunte und zehnte nicht verlängert, das neunte höchstens von der Länge des achten, das zehnte bestimmt kürzer, das elfte am längsten, doch kaum so lang wie das neunte und zehnte zusammen, mehr oder weniger seitlich zusammengepresst. Alle Glieder ohne Stiel aneinandergefügt.

Prothorax elliptisch, drei Viertel so breit wie lang, grösste Breite in der Mitte, am Halse scharf ringförmig verengt, Hinterrand durch grubige Skulptur markiert, Oberseite mässig gewölbt, ohne Mittelfurche. Prosternum gewölbt.

Elytren an der Basis kaum in Thoraxbreite, flach ausgerandet, Humerus normal, Seiten nach dem Absturz wenig und allmählich verschmälert, Hinterrand flach dreieckig ausgeschnitten, hintere Aussenecken stumpflich zugespitzt. Sutura mit Ausnahme der Basis rechtwinklig, scharfkantig über die Decken

[2] Die Gattung *Hypomiolispa* Kleine, Ent. Bl. Berlin 14 (1918) 76.

herausragend, der übrige Teil der Decken scharf gitterfurchig, Furche breiter als die Rippen, Gitterung stark. Die zweite Rippe bis auf den Absturz gehend, die dritte und vierte daselbst vereinigt, stark, leistenartig erhöht und mit der neunten verbunden, 4 bis 8 alle von gleicher Länge, die fünfte, siebente, achte, und neunte höher gekielt als die übrigen, die fünfte an der Basis verbreitert, mit Schmuckstreifen.

Vorder- und Mittelhüften etwas getrennt, kugelig. Schenkel normal, keulig, ohne Zahn, Schienen schmal, gerade, Metatarsus aller Beine länger als das dritte Glied aber kürzer als das zweite und dritte zusammen, Sohlen filzig, Klauenglied normal.

Metasternum, das erste und das zweite Abdominalsegment kräftig gefurcht, Quernaht scharf, durchgehend, das dritte und vierte gleich gross, letzteres hinten gerade.

Typus der Gattung, *Ypselogonia peregrina* sp. nov.

Ypselogonia peregrina sp. nov.

Weibchen.—Kopf und Rüssel erdbraun, Fühler rotbraun, Prothorax ziegelrot mit dunkelbraunem Halsrand, Elytren rotbraun, die fünfte Rippe bis ins hintere Viertel schwefelgelb, Unterseite mehr oder weniger dunkelbraun. Beine hellbraun, Beine und Prosternum glänzend, sonst matt. Kopf und Metarostrum chagriniert, Prorostrum und die ganze Unterseite warzig skulptiert. Basale Fühlerglieder nackt, vom fünften ab mit schwacher Behaarung, vom siebenten mehr oder weniger grubig skulptiert. Prothorax fein chagriniert.

Schenkel fast ganz glatt, Schienen und Tarsen dicht und fein chagriniert. Körperunterseite von gleicher Skulptur.

Länge, total, 5.75 Millimeter; Breite, Thorax, 1.25 circa.

MINDANAO, Dapitan.

Die neue Gattung kann nur zu den Belopherini gebracht werden. Leider sah ich keinen Mann, um das Prorostrum festzulegen. Der Verlust ist aber nicht gross, da die von anderen Gattungen trennenden Merkmale so gross sind, dass keine Verwechselung möglich ist. Keine andere Gattung hat ungezähnte Schenkel, die Art der Rippenbildung ist noch nicht beobachtet, ferner ist die Lage des Schmuckstreifens auf 5 ganz unnormal. Auch die Fühler sind insofern eigentümlich, das sie kürzere End- als Mittelglieder haben. Im übrigen ist *peregrina* in Ausfärbung und Anlage der Schmuckzeichnung ein reines Philippinentier und neigt stark dem austromalayischen Typus zu.

NEUE ARTEN AUS SANDAKAN, BORNEO

Genus **HEMICORDUS** novum

Amorphocephalidarum

Männchen.—Von Gestalt eines *Amorphocephalus*. Kopf länger als breit, vom Halse deutlich getrennt, am Hinterrand schwach nach innen geschwungen. Ueber den Augen liegt jederseits eine an *Cordus* erinnernde Leiste, die am vorderen Augenrand am schmälsten ist und sich nach hinten verbreitert und verflacht; die zwischen den Leisten liegende breite Furche daher am Hinterrand verschwommen. Vor den Augen schmale, aufrecht stehende Apophysen. Augen vorgequollen, oben und vorn gerundet, nach unten zugespitzt.

Metarostrum kürzer als der Kopf, dreieckig gegen das Mesorostrum erweitert. Die vom Kopf kommenden Leisten setzen sich scharfkantig auf den Rand fort und reichen fast bis zum Mesorostrum. Die Mittelfurche bleibt, neben derselben bildet sich vor dem Mesorostrum jederseits ein mässig erhabener Längskiel, der auf dem Mesorostrum verschwindet. Dieser Rüsselteil deutlich ausgebildet, über das Metarostrum erweitert, keulig verdickt, Mittelfurche wie auf dem Metarostrum, nach vorn erweitert. Prorostrum so lang wie das Metarostrum, nach vorn schmäler werdend, Seiten scharfkantig, vorn gerundet, das ganze Organ bildet eine von Kante zu Kante gehende Mulde, unter dem Vorderrand noch eine zungenartige Vorstülpung. Unterseite: Zwischen dem hinteren Augenrand und dem Hinterrand des Kopfes liegt eine tiefe Rinne, die sich unter den Augen entlang zieht. Die äussere Kante der Rinne verschmilzt mit den Apophysen, die innere setzt sich auf das Metarostrum fort und verschwindet am Mesorostrum, hier eine zapfenartige, glatte Fläche bildend, die von dicht chagrinierten Vertiefungen eingeschlossen wird. Mandibeln seitlich zusammengedrückt, vorn stark gezähnt.

Fühler von mittlerer Stärke, Basalglied lang, krugförmig, das zweite ohne Stiel, etwa quadratisch, das dritte kegelig, länger als breit, 4 bis 7 walzig, länger als breit (die folgenden fehlen). Alle Glieder stehen locker. Prothorax walzig-elliptisch, etwas gewölbt, ohne Mittelfurche, Hinterrand nur flach.

Elytren an der Basis breiter als der Prothorax, gegen den Absturz verengt, am Hinterrand flach, dreieckig ausgeschnitten. Alle Rippen entwickelt. Sutura breit, die folgenden Rippen

schmal, die zweite und dritte auf den Absturz gehend, die vierte im hinteren Drittel fehlend, fünfte und sechste etwas länger, die folgenden alle bis zum Rand reichend; Furchen breit und flach.

Vorder- und Mittelhüften eng stehend, fast zusammenstossend; Beine schlank.

Metasternum schmal, das erste und zweite Abdominalsegment breit gefurcht, das dritte grösser als das am Hinterrand schwach ausgerundete vierte, Apicalsegment gross, halbelliptisch, mit einer gleichgeformten flachen Vertiefung, die den grössten Teil des Segmentes einnimmt. Das dritte und vierte Segment gegen die Decken gezogen.

Es handelt sich hier um eine intermediäre Form, die zwischen *Cordus* und *Amorphocephalus* liegt. Da *Cordus* bisher auf Borneo nicht gefunden worden ist, sondern von Sumatra nach Australien und Neu-Guinea überspringt, so scheint es sich hier um eine vikariierende Gattung zu handeln. Auf Borneo findet sich eine durchaus gemischte Fauna der Amorphocephalini, hier scheinen die einzelnen Verwandtschaften an der Nordostgrenze zu liegen. Vielleicht ist *Cordus* früher ebenfalls bis hierher vorgedrungen, dann aber durch den *Amorphocephalus*-Typus verdrängt. Wichtig ist der Fund auf jeden Fall schon dadurch, als er eine Etappe der *Cordus*-artigen Formen bildet.

Typus der Gattung, *Hemicordus minax* sp. nov.

Hemicordus minax sp. nov.

Einfarbig violetbraun in verschiedenen Farbentiefen, Beine hellrotbraun, Schenkel und Schienen an Basis und Spitze und alle Tarsen am Vorderrand verdunkelt. Kopf und Rüssel nur ganz zerstreut und zart punktiert, Behaarung fehlt. Prothorax desgleichen. Elytren auf den Rippen mit weitläufigen Punkten. Unterseite des Körpers wie der Prothorax skulptiert und am Deckenrande einige grosse Punkte.

Länge, total, 9 Millimeter; Breite, Thorax, 1.25 circa.

BORNEO, Sandakan.

Die nach oben gezogenen Abdominalsegmente 4 und 5 weisen auf verwandschaftliche Nähe mit *Leptamorphocephalus* hin.

Leptamorphocephalus dissentaneus sp. nov.

Männchen.—Einfarbig tief violetbraun, fast schwarzbraun, am ganzen Körper hochglänzend.

Kopf am Hinterrand gerundet, deutlich vom Halse getrennt. Der Absturz gegen das Metarostrum beginnt erst auf der vorderen Hälfte, ist dreieckig von Gestalt, hat rundliche, unscharfe

Ränder und keine Behaarung. Skulptur aus äusserst feinen, zerstreuten Punkten bestehend, nur an der Kante zum Metarostrum dichter punktiert und einzeln zart behaart. Allgemeine Gestalt des Kopfes rundlich-walzig. Augen mittelgross, nicht über den seitlichen Kopf herausragend, flach; Unterseite gewölbt, ohne Skulptur, Gularnaht sehr klein.

Metarostrum an der Basis in üblicher Weise stark vertieft, seitlich durch die scheibenförmigen Apophysen begrenzt. Diese sowohl vom Kopf wie von dem übrigen Teil des Metarostrums völlig getrennt, dicht feinpunktiert aber unbehaart. Vorderer Teil des Metarostrums schildförmig, oberseits mehr oder weniger platt, mit schmaler, nach hinten erweiterter, abstürzender Mittelfurche, seitlich erweitert und in das mit dem Metarostrum verschmolzene Mesorostrum übergehend. Punktierung äusserst gering, Behaarung fehlt. Unterseite nach vorn keilförmig verschmälert, rundlich-walzig. Prorostrum verschmälert, nach vorn etwas an Breite zunehmend, aber immer schmäler als das Metarostrum. Die vom Letzteren kommende Mittelfurche erweitert sich, erreicht aber den Vorderrand nicht ganz; nach den Seiten steil abschüssig. Unterseite stark verbreitert, mehr oder weniger rechteckig. Mandibeln mittelgross, beide von gleicher Grösse.

Fühler robust, kurz, das erste Glied becherförmig, das zweite und dritte kegelig, das vierte etwa quadratisch, 5 bis 8 breiter als lang, walzig, das neunte und zehnte eckig-walzig, länger als breit, das elfte nicht so lang wie das neunte und zehnte zusammen. Vom fünften ab locker aneinander gefügt; alle Glieder stark grubig skulptiert.

Prothorax walzig-rundlich, ohne Mittelfurche, Skulptur aus zerstreuter, feiner Punktierung bestehend.

Elytren glatt, ausser der Skulptur ist keine Rippe vorhanden, nur an der Basis und am Absturz sind sehr geringe Reste davon sichtbar. Skulptur und Behaarung fehlt.

Beine ohne besondere Merkmale; das Klauenglied der Tarsen kurz, walzig.

Metasternum mit breiter, muldenförmiger Längsfurche. Das erste und zweite Abdominalsegment desgleichen. Naht zwischen den Segmenten nur an den Seiten erkennbar; Skulptur kaum vorhanden. Das dritte Segment grösser als das vierte, dasselbe ist gegen das fünfte nach innen ausgehöhlt. Apicalsegment sehr gross, fast ganz von einer flachen Depression eingenommen, die an der Basis des Segmentes kreisförmig von Gestalt ist. Skulptur nur am Hinterrande.

Länge, total, 7.5 Millimeter; Breite, Thorax, 1.25 circa.

BORNEO, Sandakan.

Eine Verwechselung mit anderen Gattungsverwandten ist nicht gut möglich. Die gänzliche Obliteration der Rippen ist bei keiner Art bisher beobachtet. Ebenso ist der kleine, rundliche Kopf noch nicht gesehen worden.

BEMERKUNGEN ZUR BRENTHIDENFAUNA DER PHILIPPINEN

NORD-LUZON OHNE NÄHERE BEZEICHNUNG DER FUNDSTELLE: LUZON

1. *Cyphagogus planifrons* Kirsch.
2. *Caenorychodes splendens* Kirsch.
3. *Henarrhenodes macgregori* Heller.
4. *Anepsiotes luzonicus* Calab.
5. *Hormocerus reticulatus* F.
6. *Heteroplites erythroderes* Boh.
7. *Diurus philippinicus* Senna.

SUMUAY, PROVINZ ILOCOS NORTE, LUZON

8. *Amphicordus improportionalis* Heller.

BAGUIO, PROVINZ BENGUET, LUZON

9. *Cyphagogus whitei* Westw.
10. *Miolispa pulchellea* Kleine.
11. *Schizotrachelus calabresii* Kleine.
12. *Schizotrachelus bakeri* Kleine.

IRISAN RIVER, PROVINZ BENGUET, LUZON

13. *Prophthalmus tricolor* Pow. forma *philippinensis* Kleine, ausserdem No. 3, 6.

IMUGAN, PROVINZ NUEVA VIZCAYA, LUZON

14. *Sebasius laetus* Senna.
15. *Jônthocerus bicolor* Heller.
16. *Miolispa robusta* Kleine.
17. *Miolispa clavicornis* Kleine.
18. *Hypomiolispa clavata* Kleine, ausserdem No. 3.

MOUNT LIMAY, PROVINZ BATAAN, LUZON

19. *Cerobates sexsulcatus* Motsch.
20. *Trachelizus bisulcatus* F., ausserdem No. 8, 12.

MOUNT MAQUILING, PROVINZ LAGUNA, LUZON

21. *Calodromus crinitus* Kleine.
22. *Calodromus mellyi* Guér.
23. *Sebasius pubens* Senna.
24. *Dictyotopterus philippinensis* Kleine.
25. *Stereodermus flavotibialis* Kleine.
26. *Cerobates tristriatus* F.
27. *Cerobates sumatranus* Senna.
28. *Miolispa pascoei* Kleine.
29. *Miolispa flavolineata* Kleine.
30. *Miolispa paucicostata* Kleine.
31. *Miolispa bicolor* Kleine.
32. *Hypomiolispa fausti* Senna.
33. *Baryrrhynchus* (*Eupsalomimus*) *schroederi* Kleine.
34. *Schizotrachelus corpulentus* Kleine.
35. *Diurus shelfordi* Senna, ausserdem No. 3, 9, 10, 12, 13, 19.

MOUNT BANAHAO, LUZON

36. *Cyphagogus gladiator* Kleine.
37. *Dictyotopterus pulcherrimus* Kleine.
38. *Jonthocerus pasteuri* Senna.
39. *Miolispa unicolor* Kleine.
40. *Miolispa siporana* Senna.
41. *Ectocemus badeni* Kirsch.
42. *Opisthenoplus fasciatus* Kleine, ausserdem No. 12, 13, 15, 16, 17, 19, 26, 27, 28, 29, 31, 34.

LOS BAÑOS, PROVINZ LAGUNA, LUZON

No. 12, 16, 19, 22.

MALINAO, PROVINZ TAYABAS, LUZON

43. *Miolispa fraudatrix* Kleine.
44. *Miolispa ephippium* Kleine.
45. *Miolispa strandi* Kleine.
46. *Hypomiolispa nupta* Senna.
47. *Schizotrachelus metallicus* Senna.
48. *Schizotrachelus brunneus* Kleine, ausserdem No. 19, 20, 25, 26, 27, 28, 35.

ALBAY, LUZON

49. *Miolispa pygmaea* Senna.

SURIGAO, MINDANAO

50. *Cerobates costatus* sp. nov.
51. *Hypomiolispa helleri* Kleine.
52. *Hypomiolispa exarata* Desbr., ausserdem No. 20, 41.

BUTUAN, MINDANAO

53. *Jonthocerus asiaticus* Kleine.
54. *Hypomiolispa tracelizoides* Senna.
55. *Heteroplites spinifer* Kleine, ausserdem No. 27, 28, 35, 46, 51.

ILIGAN, MINDANAO

56. *Cyphagogus longisetosus* Kleine.
57. *Jonthocerus laticostatis* Kleine.
58. *Cerobates adustus* Senna.
59. *Miolispa discors* Senna.
60. *Prophthalmus longirostris* Gyll.
61. *Caenorychodes serrirostris* Fabr.
62. *Apterorrhinus compressitarsis* Senna, ausserdem No. 8, 20, 27, 28, 29, 46, 47, 51, 52, 54, 55.

KOLAMBUGAN, MINDANAO

63. *Opisthenoxys ochraceus* Kleine.
64. *Higonius poweri* Lew.
65. *Miolispa persimilis* sp. nov.
66. *Diurus furcillatus* Gyll., ausserdem No. 3, 19, 20, 29, 33, 35, 57.

DAPITAN, MINDANAO

67. *Cerobates grouvellei* Senna.
68. *Ypselogonia peregrina* sp. nov.
69. *Achrionota bilineata* Pascoe.
70. *Schizotrachelus inconstans* Kleine, ausserdem No. 20.

DAVAO, MINDANAO

71. *Miolispa cruciata* Senna.
72. *Miolispa borneensis* Senna.
73. *Miolispa affinis* Kleine.
74. *Eupsalis* (*Schizoeupsalis*) *kleinei* Heller, ausserdem No. 5, 8, 12, 16, 19, 22, 34, 36, 51, 61, 70.

ZAMBOANGA, MINDANAO

75. *Miolispa elongata* Kleine, ausserdem No. 9, 12, 19, 24, 47, 52, 55, 63, 70.

AGUSAN, MINDANAO

No. 6

TAGOLOAN [8]

No. 5, 19, 20.

BASILAN

76. *Cediocera tristis* Senna, ausserdem No. 19, 29, 35, 36, 51, 52, 75.

PUERTO PRINCESA, PALAWAN

77. *Hoplopisthius trichimerus* Senna, ausserdem No. 19.

TAYTAY, PALAWAN

No. 6.

SÜD-PALAWAN, PALAWAN

No. 61.

Nach den Tribus verteilen sich Gattungen und Arten folgendermassen:

1. Calodromini. 5 Gattungen mit 11 Arten. Nur eine Gattung ist endemisch, neue Formen haben sich nicht ergeben.
2. Stereodermini. 3 Gattungen mit 11 Arten. Von ganz besonderem Interesse ist die Feststellung, dass *Stereodermus* in einer sicheren Art vorkommt. Der Verbreitungkreis dieser schon weit verbreiteten Gattung wird dadurch noch erweitert.
3. Trachelizini. 5 Gattungen mit 27 Arten. Auffällig ist die grosse Zahl an *Miolispa*-Arten (19), die sicher noch viel grösser ist. Neue Formen sind nicht gefunden worden.
4. Arrhenodini. 5 Gattungen mit 7 Arten. Am meisten interessiert die neue Gattung *Amphicordus*, die in ihrer gedrungenen, ganz abweichenden Gestalt kaum einer Arrhenodini ähnlich sieht und als ein entarteter Zweig des Verwandtschaftskreises anzusehen ist.

[8] Of José Algue, Atlas de Filipinas (1899) No. 27. On Baker's label, Tangcolan.

5. Belopherini. 4 Gattungen mit 4 Arten. Zwei Gattungen sind endemisch und neu.
6. Ceocephalini. 4 Gattungen mit 9 Arten, darunter keine neue Formen.
7. Ithystenini. 4 Gattungen mit 8 Arten; keine neue Formen.

Von den 30 Gattungen sind 4 Endemismen, von 77 Arten 38.

Ueber die Verwandtschaft zu den umliegenden Gebieten wäre folgendes zu sagen: Mit Borneo sind gemeinsam 3 Arten, mit Java 2 Arten, mit Sumatra 4 Arten, mit den Sundainseln allgemein 6 Arten, dabei sind einige, die von Ceylon bis Neu-Guinea überall verbreitet sind, nicht mit eingerechnet. Sechs Arten lassen sich bis Malakka verfolgen, einige sind bisher nur dort und auf den Philippinen gefunden, leben aber auch in den Zwischengebieten. Bis nach Ostindien ist eine Art verbreitet, bis Ceylon 4, 3 davon sind Ubiquisten. Bemerkenswert ist, dass die beiden aufgefundenen *Sebasius*-Arten auch in Birma leben.

Die mandschurische Fauna weist nur wenige Anklänge auf. Auf Formosa 2, davon eine nur dort und auf den Philippinen, Süd-China 1 Art (weitverbreitet).

Die Zahl der Arten aus den austromalayischen und australischen Gebieten ist klein. Mit Celebes fand ich 4 Arten gemeinsam, darunter zwei weitverbreitete und aus dem asiatischen Verbreitungsgebiet kommende. Im übrigen habe ich nur eine Art australischer Provenienz gesehen: *Baryrrhynchus* (*Eupsalomimus*) *schröderi,* die vom östlichen Neu-Guinea über die Molukken-Philippinen bis Tonkin zu verfolgen ist.

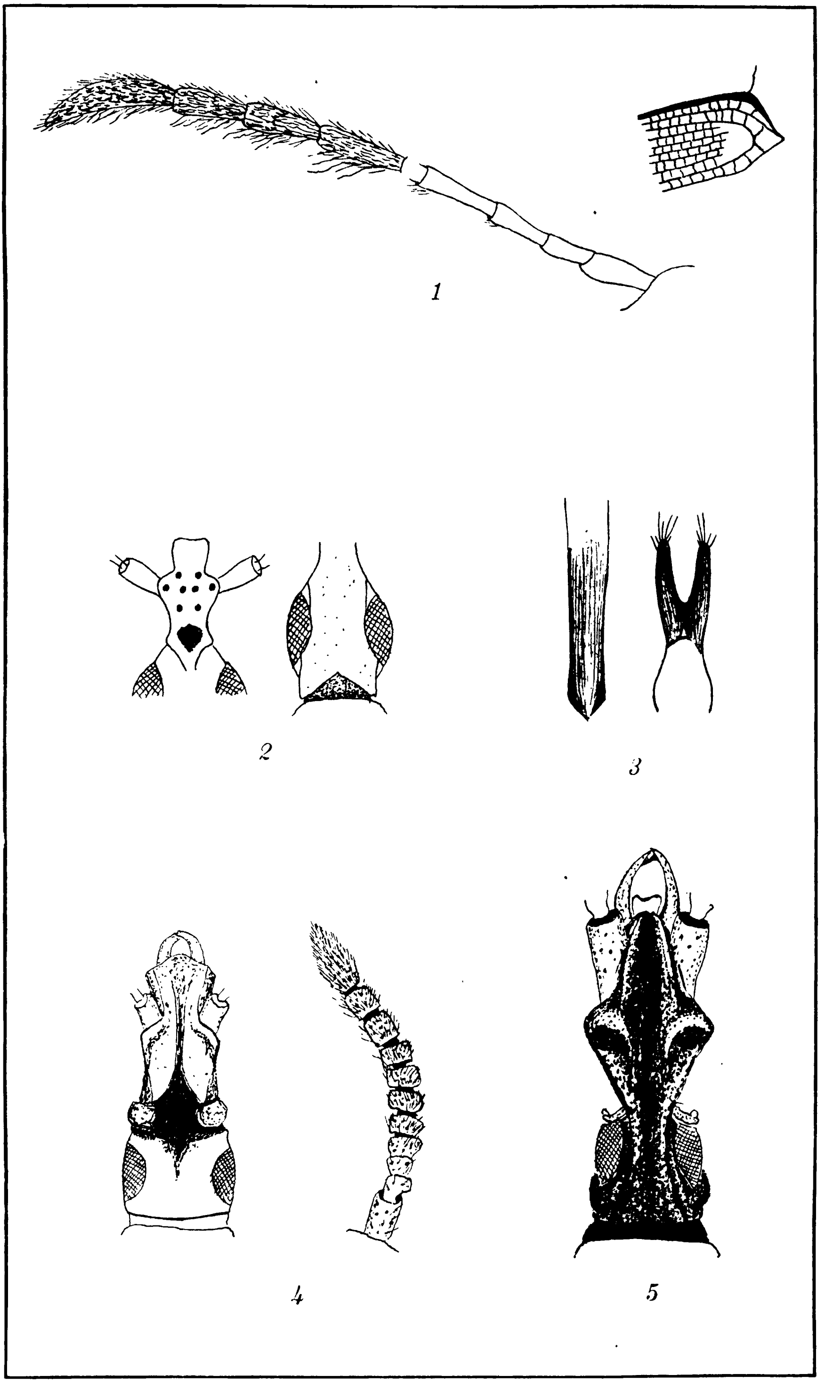
Nach den bisherigen Ergebnissen muss die Philippinenfauna als vorherrschend asiatisch angesehen werden, die Australier treten ganz in den Hintergrund. Dennoch ist eine Anlehnung an die Neu-Guineafauna ganz ohne Frage und zwar ohne Berührung der Molukken und von Celebes. Die für die Neu-Guineafauna charakteristische Doppelfärbung, roter Prothorax (eventuel auch Kopf und Rüssel) im Gegensatz zur dunklen Allgemeinfärbung, konnte ich an 10 Arten feststellen. Kein anderes Gebiet hat dieses Charakteristikum.

Von den 38 Endemismen kommen 29 auf Luzon, 9 auf Mindanao vor, Palawan hat keine mehr. Die doppelfarbigen Arten leben alle auf Luzon. Die Einwanderung asiatischer Elemente scheint also über Palawan stattgefunden zu haben, während auf Luzon auch austromalayische Einflüsse zu bemerken sind. Die Brenthidenfauna der Philippinen scheint demnach Mischcharakter zu haben.

TAFELERKLÄRUNG

TAFEL 1

FIG. 1. Fühler und Deckenabsturz von *Ypselogonia.*
2. Kopf und Rüsselunterseite von *Cerobates costatus.*
3. Penis und Parameren von *Miolispa persimilis.*
4. Kopf und Fühler von *Leptamorphocephalus dissentaneus.*
5. Kopf von *Hemicordus.*



TAFEL 1. NEUE BRENTHIDEN.

FOLIAR TRANSPIRING POWER OF THE COCONUT[1]

By Sam F. Trelease

Of the Johns Hopkins University

ONE TEXT FIGURE

The purpose of this article is to describe the results of tests on the daily march of transpiring power of coconut (*Cocos nucifera* Linn.) leaves, as indicated by standardized cobalt-chloride paper. The method used was essentially the same as that described by Livingston (6) with, however, some of the modifications suggested by Trelease and Livingston, (14) and by Livingston and Shreve. (10) Small slips of filter paper impregnated with cobalt chloride were used; when dry the slips are bright blue, but upon absorbing moisture they gradually become pale blue, then pale lavender, and finally pink. The cobalt-chloride method of determining transpiring power involves a determination of the ratio obtained by dividing the time-period for a given color change over a standard evaporating surface (water-saturated porous clay covered with a millimeter of air) by the time-period for the corresponding change upon the leaf surface at the same temperature; the index of transpiring power thus obtained shows the relative power of the plant surface to give off water vapor, as compared with the corresponding power of the standard water surface. In the present tests the abundance of moisture in the atmosphere made it difficult to use the bright blue color as the initial shade (as recommended by Livingston and Shreve), and so the pale blue standard color used by the authors just mentioned was employed, the time being recorded for the change from the Livingston-Shreve pale blue standard to pink. The slips were standardized once for all in the laboratory, and each slip was given a coefficient, by which was obtained the time-period for the change over the standard evaporating surface at each time when leaf tests were made.[2] After standardization the slips were dried and then placed in small desiccators containing calcium chloride.

[1] Botanical contribution from the Johns Hopkins University, No. 72.

[2] See article by Livingston and Shreve (10) that is cited at the end of this paper.

A test upon a coconut leaf was made by holding a dried slip in contact with the lower surface of the leaf by means of a small glass clip, and noting the number of seconds required for the color change from pale blue to pink. The leaf was shaded during the test by means of a cheese-cloth screen, and the temperature of the air, which was assumed to be practically the same as that of the leaf, was recorded.[3]

As has been shown by several studies, the length of the time-period for a given color change over the standard evaporating surface depends, for any slip of paper, upon the temperature alone, this time-period being inversely proportional to the maximum vapor pressure of water corresponding to the given temperature.[4]

An example may illustrate the way in which calculations are made. In one of the tests, for a certain slip of cobalt paper the time-period for the color change on the leaf was 77 seconds when the air temperature was 23.7° C., corresponding to a vapor pressure of water of 21.76 millimeters. Since the slip of cobalt paper had required 31.9 seconds for the change over the standard surface when the temperature was 27.4° C., corresponding to a vapor pressure of 27.10 millimeters, the time-period required for the change over the standard surface at the temperature of the leaf would have been $31.9 \times 27.10 \div 21.76$, or 40 seconds. In this test the index of transpiring power, being the time required for the change over the standard surface divided by the time required for the change over the leaf at the same temperature, was 40 divided by 77, or 0.52. In making the calculations the table of vapor-pressure ratios given by Livingston and Shreve(10) was employed.

Tests were made upon coconut plants growing in the open field on April 29, April 30, May 3, May 4, May 7, May 8, May 9, May 10, and May 11, 1918. The experiments were conducted at the College of Agriculture, of the University of the Philippines, at Los Baños. The writer is indebted to Messrs. F. de Peralta and P. David for assistance in the experiments. Column 2 of Table 1 gives the average actual values derived from these tests, showing the indices of transpiring power for the various hours during the day and night. Since similar plants were used for all the tests and the environmental conditions did not vary

[2] See Edith B. Shreve.(13)

[4] See Bakke,(1) Livingston and Shreve,(10) and Trelease and Livingston.(14)

markedly from day to day, it seems reasonable to regard these averages as representing what may be expected to be the general course of the daily march of transpiring power for these plants at this season of the year.

TABLE 1.—*Fluctuation in the index of foliar transpiring power of Cocos nucifera, as indicated by standardized cobalt-chloride paper, and variation in apparent pinna width, together with evaporation data.*

[Relative values show percentage of range from lowest to highest values.]

Observation.			Index of transpiring power (lower surface).		Average apparent pinna width.		Evaporating power of the air (white spherical atmometer).	
No.	Time.		Actual.	Relative.	Actual.	Relative.	Actual.[a]	Relative.
	a. m.	*p. m.*			*mm.*			
1	6		0.56	100	33.4	78	----------	----------
2	7		0.52	87	----------	----------	0.8	28
3	8		0.52	87	32.6	58	1.3	45
4	9		0.53	90	----------	----------	1.9	66
5	10		0.52	87	31.3	25	2.3	79
6	11		0.49	77	----------	----------	2.7	93
7	12		0.46	67	30.3	0	2.8	97
8		1	0.45	63	----------	----------	2.9	100
9		2	0.44	60	30.9	15	2.8	97
10		3	0.42	53	----------	----------	2.7	93
11		4	0.39	43	31.2	23	2.4	83
12		5	0.40	47	----------	----------	1.9	66
13		6	0.38	40	32.2	48	0.6	21
14		7	0.36	33	----------	----------	0.5	17
15		8	0.35	30	32.8	63	0.3	10
16		10	0.27	3	34.3	100	0.1	3
17		12	0.27	3	34.3	100	0.0	0
18	2		0.26	0	34.3	100	0.0	0
19	3		0.33	23	----------	----------	----------	----------
20	4		0.36	33	34.2	98	0.0	0
21	5		0.52	87	----------	----------	0.1	3
22	6		0.54	93	33.8	88	0.4	14

[a] Cubic centimeters per hour for preceding hour.

As has been pointed out by Copeland,(5) there is a strand of colorless, thin-walled cells running along each side of the midrib on the undersurface of the coconut pinna, and these strands act as hinges. When the leaves are well supplied with water, the hinge cells are distended and the two pinna wings are held far apart; but when there is a progressive deficiency of water in the hinge cells, the wings of the pinna revolve downward, about the pinna midrib as an axis, so that their lower faces approach each other. The angle of divergence between the two pinna wings may be approximated by measuring the distance between

the two free, parallel edges. To study the daily fluctuations in "opening" and "closing" of the pinna, the distance between the two free edges of the pinna (called the "apparent width") was measured immediately after making each cobalt-chloride-paper test. The data thus obtained are given in column 4 of Table 1.

A Livingston white spherical atmometer, placed in full sunlight near the plants, was read at the times of measurement, in order to determine the evaporating power of the air, and the evaporation data are given in column 6 of Table 1.

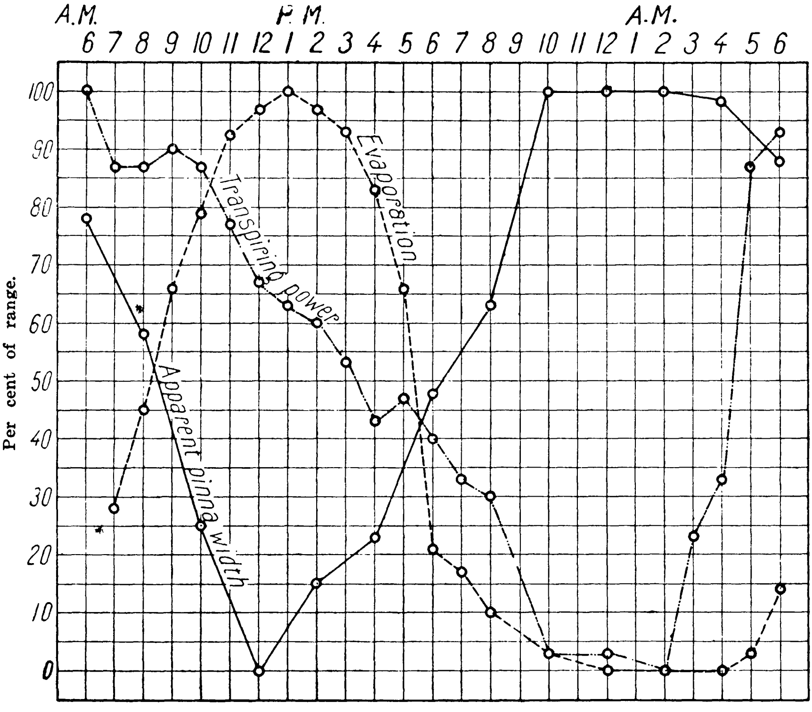


FIG. 1. Graphs showing transpiring power (dot and dash line) of *Cocos nucifera;* apparent pinna width (full line), and evaporating power of the air (dash line)—all plotted in percentage of range from lowest to highest values. (Data are from Table 1.)

To facilitate comparison between the changes in transpiring power, apparent pinna width, and evaporating power of the air, the actual values presented in the table have also been expressed as relative values, in terms of percentage of the total range in each case; and these relative values are shown for the three kinds of data in columns 3, 5, and 7, respectively. Transpiring power, for example, ranges in value from 0.26 to 0.56, the total range being 0.30. This range was divided into one hundred equal parts, and each actual value is expressed in the table as

a relative value in terms of the percentage of the range from the lowest to the highest actual value. These relative values, reduced to this uniform basis are presented graphically in fig. 1, in which the dot and dash line represents transpiring power; the full line, apparent pinna width; and the dash line, evaporating power of the air.

Inspection of the graph of foliar transpiring power (dot and dash line) shows that this has its maximum value at 6 a. m., a short time after sunrise. Approximately the maximum was maintained until 11 a. m. Then the index of transpiring power decreased rather gradually and uniformly until 8 p. m., and then decreased rapidly to a low night value. This low night index was maintained approximately constant until 2 a. m. From 2 to 4 a. m. there was a slight increase in the index of transpiring power, and from 4 to 6 a. m. there was a rapid increase to approximately the maximum value. The graph of the daily march of transpiring power of coconut thus resembles in a general way the published graphs showing transpiring power for other kinds of plants studied by the same method.[5] It is worthy of mention, however, that the maximum occurred earlier in the day for coconut than for other plants tested, and that the decrease in transpiring power therefore occurred earlier. Also, in coconut, although there was a fall in transpiring power during the time of approximately maximum evaporation rates, there was not the subsequent pronounced rise found by Bakke(3) for *Helianthus*.

Inspection of the graph (full line) that represents changes in the distance between the edges of the pinnae shows that this apparent width decreased uniformly from 6 a. m. until noon, and then increased uniformly until a maximum width was reached at 10 p. m.; this maximum was then maintained throughout the remaining hours of darkness. This graph illustrates the kind of change that is usually observed during the day in the apparent width of the pinnae. It is interesting to compare this graph with the graph (dash line) representing the hourly changes in the evaporating power of the air. Such a comparison shows that the changes in the evaporating power of the air exhibited a general inverse relationship to variations in the apparent width of the pinnae, since the evaporating power increased from 6 a. m. until noon and then decreased in the afternoon and reached a very low value after dark, the low value being maintained

[5] See Bakke, (1, 2, 3, 4) Livingston, (6) Shive and Martin, (12) and Trelease and Livingston. (14)

until nearly sunrise. After a period of rapid transpiration, due to high evaporation rates, Livingston and Brown(7) found that the water content of many kinds of leaves is markedly lower than it is after a period of slow transpiration (soil-moisture conditions remaining about the same), and that the diminished water content or incipient drying is in a general way proportional to the evaporation rates. Since apparent pinna width decreases with increased evaporation rates and increases with decreased evaporation rates, this inverse relationship may be taken as evidence of the truth of the assumption made by Copeland(5) that apparent pinna width may be used as an index of the water content of the hinge cells.

Returning to a consideration of the graph for transpiring power (dot and dash line), it will be of interest to discuss briefly, from our present knowledge of the water relations of plants, the influences that may be effective within the plant to bring about the increase in transpiring power to high values in the early morning, the decrease throughout the latter part of the day, and the decrease to low night values.

For many plant species foliar transpiring power has been found, in numerous investigations, to depend very largely upon the condition of the stomata—the stomatal aperture, or diffusive capacity, being by far the most powerful influence taking part in the control of foliar transpiring power of many plant species.[6] Thus the openness of the stomata frequently has such an important influence upon the daily march of transpiring power that other influences may safely be disregarded. It has long been known that the stomata of most kinds of plants respond to the stimulus of light by opening, and that in darkness they close; thus stomata are usually open during the day, and more or less completely closed at night.[7] But stomata also tend to close, as many observations have shown, when the water content of the leaf tissues becomes reduced as a result of high rates of transpiration accompanied by inadequate absorption, especially when the leaves have become noticeably wilted.[8] Besides the stomatal condition, another influence that may possibly have a pronounced effect upon transpiring power is the partial pressure of water vapor in the sub-stomatal spaces of the leaf; this should depend upon the state of the leaf tissues.[9]

[6] See Trelease and Livingston.(14)

[7] See Livingston and Estabrook.(8)

[8] See Lloyd.(11)

[9] See Livingston and Brown (7) and Trelease and Livingston.(14)

From the generally known facts briefly outlined above, the explanation may be advanced that the high transpiring power of coconut observed during the early hours of sunshine resulted from the fact that the stomata were wide open and that the leaf tissues were nearly saturated with water. The marked decrease beginning at about 11 a. m. was probably due to partial closure of the stomata and decreased partial pressure of water vapor in the leaf, both of these conditions probably depending upon a diminished water content of the leaf tissues. That such a diminution did occur is suggested by the observed decrease in the apparent pinna width. But it will be noted that the decrease in transpiring power continued during the afternoon, after the apparent pinna width had begun to increase—that is, after the water content of the hinge cells had apparently begun to increase. This may be taken to mean that the hinge cells respond more quickly (and with different critical values) to changes in water content than do the other leaf cells, which control transpiring power; apparently, although the water content of the hinge cells begins to increase in the early afternoon, the other leaf cells may still exhibit marked and increasing incipient drying, which may maintain a low partial pressure of water vapor in the sub-stomatal spaces of the leaf, or a reduced stomatal aperture, or both conditions together. The rest of the leaf tissues (or those controlling transpiring power) appear to go on drying out long after the hinge cells have passed their minimum of turgidity, and have begun to increase in size, thus lifting the pinna wings. The continued reduction in transpiring power in the very late afternoon may be regarded as due to stomatal closure in response to the reduced light intensity accompanying the setting of the sun; and the fall in transpiring power to the very low night values no doubt resulted from partial stomatal closure accompanying darkness. Such partial closure during the night is, of course, generally observed in plants having active stomata. The low values were maintained during the night until 3 a. m., and the very rapid increase in transpiring power from 4 to 6 a. m. was apparently due to the well-known rapid opening of the stomata during the period about sunrise.

The present tests were made upon only the lower surfaces of the leaves, because the stomata of coconut are limited to the lower surface; and preliminary tests showed that the transpiring power of the upper surface is extremely low, almost zero. Copeland(5) states that at least 98 per cent of the water trans-

pired by coconut is given off from the lower surfaces. Thus, considering both surfaces, the transpiring power would have values approximately half as great as those shown in Table 1; the maximum value would therefore be about 0.28, and the minimum, 0.13.

It should be emphasized that this paper deals with fluctuations in transpiring power, not in transpiration. Transpiring power represents only the group of internal conditions influencing the transpiration rate, which of course is also greatly influenced by environmental conditions. As numerous studies have shown, the actual amount of water transpired in a certain period of time from a given area of leaf depends upon two sets of conditions: (*a*) the transporting power of the leaf surface (controlled by the anatomical structure of the leaf, the number, distribution, and openness of the stomata, the way in which the leaf is exposed, the degree of saturation of the leaf with water, etc.), and (*b*) the effective external conditions surrounding the leaf (controlled principally by the evaporating power of the air—temperature of the air, moisture content of the air, movement of the air—and the intensity of the absorbed sunshine). Since, as is illustrated by the actual values in Table 1 and as has been shown by a number of investigations, the relative change in the most influential of the external conditions (the evaporating power of the air) is much greater from hour to hour or from night to day than is the relative change in transpiring power, it of course follows that changes in the actual rate of transpiration are determined very largely for a particular plant species by changes in the external conditions. Accordingly, for the whole night, as was found by Copeland,(5) the total transpiration from a coconut leaf may not be as much as one-tenth as great as for one hour of full sunshine. All studies thus far reported agree in showing that from night to day the transpiring power usually increases but slightly; in the present tests it increased in actual value from 0.26 to 0.56—that is, it became only about twice as great during the day as it was at night; the evaporating power of the air, however, in the day frequently becomes many times as great as it is at night. Numerous investigations with many kinds of plants have shown that the actual transpiration rate during the daylight hours may often be more than thirty times as great as during the hours of darkness. The transpiration rate is of course proportional to the product of the transpiring power of the plant and the evaporating power of the air, and the high rates of transpiration during the day

thus result from a small increase in transpiring power and a very great increase in the evaporating power of the air. For a further discussion of these features, the reader is referred to the literature; our present knowledge of the quantitative water relations of plants has been largely developed in the publications by Livingston.[10]

It should be mentioned, in connection with a consideration of the results of these tests, that the best-known methods for studying transpiring power may be expected to give somewhat different results when used on a plant such as coconut, in which the exposure of the leaf surfaces undergoes diurnal alterations. Only one of these methods (the one depending upon the power of the leaf surface to give off water vapor to a standard water-absorbing surface) was used in the present experiments. The other method, also devised by Livingston,[11] involves a comparison between absolute rates of transpiration and rates of water loss from some form of atmometer, the white spherical instrument being generally satisfactory; by this method the quotient of the transpiration rate divided by the evaporation rate from the standardized atmometer, for the same time-period and exposure, is used as a measure of transpiring power. It is not the purpose of this discussion to give a detailed comparison of these two methods, since only one of them was used in these tests; but one difference, which has not been emphasized in the literature, appears worthy of mention when coconut is considered. This dissimilarity is connected with the well-known fact that the position, or direction of exposure, of the leaf surface influences its transpiring power; thus it is generally recognized that a leaf, so placed that the rays of sunlight fall on it at right angles, is of course likely to transpire more rapidly than a similar leaf so placed that the rays strike it at a smaller angle; also, it has long been known that a leaf, freely exposed to the movements of the air, has a tendency to transpire more rapidly than a similar leaf that is protected from air currents. It is evident, as was pointed out by Copeland, (5) that the wings of the coconut pinna, when folding together in the middle of the day, alter their position in such a way as to tend to receive the sunlight obliquely and also to protect the lower, transpiring surface from air currents—the alteration in exposure thus tending to decrease transpiring power in these two ways. The two methods for measuring transpiring power may thus be expected to give

[10] For citations of literature, see Livingston and Hawkins. (9)

[11] See Livingston and Hawkins. (9)

somewhat different results, since the cobalt-paper method fails to detect differences in transpiring power due to changes in leaf position. It may be suggested, in conclusion, that the influence of such changes in leaf exposure as are here considered is a topic worthy of experimental investigation.

BIBLIOGRAPHY

1. BAKKE, A. L. Studies on the transpiring power of plants as indicated by the method of standardized hygrometric paper. Journ. Ecol. **2** (1914) 145–173.
2. BAKKE, A. L. The index of foliar transpiring power as an indicator of permanent wilting. Bot. Gaz. **60** (1915) 314–319.
3. BAKKE, A. L. Determination of wilting. Bot. Gaz. **66** (1918) 81–116.
4. BAKKE, A. L., and LIVINGSTON, B. E. Further studies on the foliar transpiring power in plants. Physiol. Res. **2** (1916) 51–71.
5. COPELAND, E. B. The coco-nut. Macmillan and Co. London (1914) 212.
6. LIVINGSTON, B. E. The resistance offered by leaves to transpirational water loss. Plant World **16** (1913) 1–35.
7. LIVINGSTON, B. E., and BROWN, W. H. Relation of the daily march of transpiration to variation in the water content of foliage leaves. Bot. Gaz. **53** (1912) 309–330.
8. LIVINGSTON, B. E., and ESTABROOK, A. H. Observations on the degree of stomatal movement in certain plants. Bull. Torrey Bot. Club **39** (1912) 15–22.
9. LIVINGSTON, B. E., and HAWKINS, LON A. The water-relation between plant and soil. Carnegie Inst. Washington Pub. **204** (1915) 5–48.
10. LIVINGSTON, B. E., and SHREVE, E. B. Improvements in the method for determining the transpiring power of plant surfaces by hygrometric paper. Plant World **19** (1916) 287–309.
11. LLOYD, F. E. Leaf water and stomatal movement in Gossypium and a method of direct visual observation of stomata in situ. Bull. Torrey Bot. Club **40** (1913) 1–26.
12. SHIVE, J. W., and MARTIN, W. H. The effect of surface films of Bordeaux mixture on the foliar transpiring power in tomato plants. Plant World **20** (1916) 67–86.
13. SHREVE, E. B. The role of temperature in the determination of the transpiring power of leaves by hygrometric paper. Plant World **22** (1919) 172–180.
14. TRELEASE, S. F., and LIVINGSTON, B. E. The daily march of transpiring power as indicated by the porometer and by standardized hygrometric paper. Journ. Ecol. **4** (1916) 1–14.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Graphs showing transpiring power (dot and dash line) of *Cocos nucifera;* apparent pinna width (full line), and evaporating power of the air (dash line), all plotted in percentage of range from lowest to highest values. (Data are from Table 1.)

THE CULTIVATION OF LEISHMANIA INFANTUM AND LEPTOMONAS CTENOCEPHALI ON THE TRIPLE-N MEDIUM [1]

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INTRODUCTION

The successful cultivation of trypanosomes on the artificial medium of Novy and MacNeal (3) has led in the past to its trial for *Leishmania.* The present inquiry was intended to find out what minimal amounts of blood could be used provided the proportion of agar be altered from that used in the original formula; and to what extent different degrees of softness of the whole medium would influence the growth of these protozoans.

MATERIAL AND PROCEDURE

Strains of *Leishmania infantum* and *Leptomonas ctenocephali,* which were furnished me through the kindness of Prof. E. E. Tyzzer, of the department of comparative pathology, Harvard Medical School, were used in these experiments. It was thought best to study these two organisms; because, while they have pronounced morphological similarities, they exhibit distinct biological manifestations, as *L. infantum* is the etiologic agent of a severe disease, infantile kala-azar, and the other is apparently a harmless parasite in the gut of the common dog flea.

Two culture media, one containing 2 per cent agar and the other 0.5 per cent agar, were used, to which different proportions of blood were added. The complete formulæ of the media are as follows:

Two per cent agar culture medium.

Agar-agar (grams)	20
Sodium chloride (grams)	4
Water (cc)	1,000

One-half per cent agar culture medium.

Agar-agar (grams)	5
Sodium chloride (grams)	4
Water (cc)	1,000

[1] Received July 1, 1921. From the laboratories of the College of Medicine and Surgery, University of the Philippines, and the Harvard School of Tropical Medicine.

These were heated in a flask until all of the agar was dissolved. One cubic centimeter of the mixture was placed in each of the small test tubes, which were autoclaved. The medium was then cooled to about 45° C.; different amounts of defibrinated rabbit's blood were then added and allowed to cool as slants. The organisms were streaked on the surface of the agar by means of a platinum loop.

This formula is essentially that of Nicolle,(2) which is a modification of Novy-McNeal's medium for trypanosomes. As modified by Nicolle, the medium consists only of agar, sodium chloride, water, and defibrinated rabbit's blood. The meat extract and peptone employed in the original formula are not used. This is best known as the triple-N or N. N. N. (Nicolle-Novy-McNeal) medium. Nicolle designed it for the cultivation of the organisms from a case of infantile splenic anæmia which he studied at Tunis. As the flagellates he recovered from the spleen showed similarity to *Leishmania donovani* he placed them in the same genus, but assigned to them a new specific name—*Leishmania infantum.*

It is worthy of note that Cristina and Cannata(1) also succeeded in growing *Leishmania infantum* by using media to which various other components were added, such as ascitic fluid, glycerine, bouillon, rabbit's serum, etc.

The results of the cultivation experiments are given in Tables 1 to 4.

TABLE 1.—*Leishmania infantum grown in 0.5 per cent agar plus different percentages of defibrinated rabbit's blood. Cultures inoculated December 1, 1920.*

5 per cent blood.	10 per cent blood.	25 per cent blood.	Date of examination.
Only one active organism was seen in several microscopic fields.	Negative	Negative	December 2, 1920.
Very scarce	do	do	December 3, 1920.
Numerous organisms	Good growth	Rather poorer growth.	December 6, 1920.
Many active organisms present (fewer than in 2 per cent agar-25 per cent blood examined on the same day.	Moderate growth; active ones also in water of condensation.	Slight growth	December 11, 1920.
Abundant growth	Moderate growth	do	December 17, 1920.
Good growth	Good growth	Poor growth	December 29, 1920.

INTERPRETATION OF RESULTS

The observations of the cultures from time to time as recorded in Tables 1 to 4 furnish indications with respect to certain re-

quirements for growth of these parasitic flagellates. Each of the two variables, namely, the amounts of agar-agar and of blood, as important constituents of the medium, has its own effect on their continued life.

TABLE 2.—*Leishmania infantum grown in 2 per cent agar plus different percentages of defibrinated rabbit's blood. Cultures inoculated December 1, 1920.*

5 per cent blood.	10 per cent blood.	25 per cent blood.	Date of examination.
Very few active organisms	Very few active organisms.	Very few active organisms.	December 2, 1920.
Do	do	Good growth	December 3, 1920.
Abundant growth	Abundant growth	Very abundant growth.	December 6, 1920.
Only trace of a few living organisms. Many dead individuals.	Good growth	Numerous active organisms; very good growth.	December 11, 1920.
Still a few living organisms	Numerous organisms.	Very numerous organisms. Isolated ones and also in clumps.	December 17, 1920.
Many dead organisms	Good growth	Very numerous	December 29, 1920.
Negative	Negative	Many granulated and degenerating forms. Some active.	February 6, 1921.

TABLE 3.—*Leptomonas ctenocephali grown in 0.5 per cent agar plus different percentages of defibrinated rabbit's blood. Cultures inoculated December 1, 1920.*

5 per cent blood.	10 per cent blood.	25 per cent blood.	Date of examination.
A few live organisms	A few live organisms.	A few live organisms.	December 2, 1920.
Good growth	Good growth	Good growth	December 3, 1920.
Very good growth	Very good growth	Very good growth	December 6, 1920.
Numerous	Numerous	Very numerous, many rosettes.	December 11, 1920.
Do	do	Very numerous	December 17, 1920.
Numerous; many dead organisms.	Numerous; many dead organisms.	do	December 29, 1920.

The addition of blood to the medium proved to be of distinct advantage and almost an essential in the hands of previous workers. However, it seems that consistency of the medium as a whole exerts no little influence. For instance, the writer got just as good results when using 0.5 per cent agar with 5 per cent blood as when he employed 2 per cent agar with 25 per cent

blood. Furthermore, better growth was obtained in 0.5 per cent agar with 5 per cent blood than in 2 per cent agar with 5 per cent blood, showing that the amounts of blood being equal, the resulting harder consistence of the latter due to a greater proportion of agar contained in it has given rise to lessened suitability of the medium for growth of the parasites.

TABLE 4.—*Leptomonas ctenocephali grown in 2 per cent agar plus different percentages of defibrinated rabbit's blood. Cultures inoculated December 1, 1920.*

5 per cent blood.	10 per cent blood.	25 per cent blood.	Date of examination.
Very few living organisms	Very few living organisms.	Very few living organisms.	December 2, 1920.
Some growth	Some growth	Fairly abundant	December 3, 1920.
Do	Fairly abundant	Numerous	December 6, 1920.
Numerous	Numerous	Very numerous	December 11, 1920.
Good growth	do	Very numerous, many rosettes.	December 17, 1920.
Good growth; not many dead organisms present.	Fairly good growth	Very abundant	December 29, 1920.
Negative	Negative	Numerous active organisms.	February 19, 1921.

It was also evident in the cultures that *Leptomonas ctenocephali* seems to be less sensitive than *Leishmania infantum* as to changes in consistency of the medium, as no distinct deleterious effect was noticeable, particularly during the first days of the culture, by the use of varying amounts of either blood or agar. However, examination on February 19, 1921 (Table 4), something over two and a half months after the inoculation, showed that there was still growth in the 2 per cent agar and 25 per cent blood medium, while the other blood combinations of the 2 per cent agar yielded no growth at this time.

To summarize: Strains of *Leishmania infantum* and *Leptomonas ctenocephali* were used for cultivation experiments. Successful growth was obtained by using even a trace of blood provided the agar was very soft. The 2 per cent agar plus 25 per cent blood and the 0.5 per cent agar plus 5 per cent blood combinations seem to offer optimal conditions for growth.

I beg to acknowledge my gratitude to Professors E. E. Tyzzer and A. W. Sellards for the help they gave me while I was working in the laboratory of the Harvard School of Tropical Medicine.

REFERENCES

1. CRISTINA, G. D., and CANNATA, S. Ueber die Morphologischen und Kulturellen Eigenschaften des Parasiten der infantilen Milzanämie (Leishmania infantum). Cent. f. Bakt. etc. **55** (1910) 494.
2. NICOLLE, M. C. Le kala azar infantile. Ann. Inst. Past. **23** (1909) 361.
3. NOVY, F. G., and MCNEAL, W. J. The cultivation of Trypanosoma brucei. Journ. Am. Med. Assoc. **41** (1903) 1266.

THE DIGESTIVE PROPERTIES OF PHILIPPINE PAPAIN [1]

By HARVEY C. BRILL and ROBERT E. BROWN

THREE TEXT FIGURES

Many methods have been proposed and their efficiency tested for measuring the proteolytic properties of papain and of other proteolytic enzymes. Some of these methods will be found in the references cited.[2]

D. S. Pratt [3] made use of a 40 per cent solution of sweetened, condensed, skimmed milk as his substrate and a 0.5 per cent water solution of papain as his enzyme solution. In his experiments these solutions were mixed and at the end of the digestion time the undigested casein was precipitated by the addition of 0.5 cubic centimeter of copper sulphate solution (60 grams per liter) followed by 0.5 cubic centimeter of glacial acetic acid accompanied by vigorous stirring during the precipitation. The precipitated casein was broken up, washed several times on the filter, dried in the oven, and weighed. By making use of a blank the percentage of casein digested was calculated. This method was thoroughly tried out, and reliable results were obtained in his investigation. Because of its simplicity and reliability we have adopted the same method in our work.

EXPERIMENTAL

Several samples of papain which had been used by Pratt in his work in 1914 were examined by us (seven years later) for proteolytic activity, and found to have lost all such activity. These samples represented papain that was extremely active

[1] Contribution from the chemical laboratory of Miami University, Oxford, Ohio.

[2] Delauny and Bailly, Bull. Sci. Pharm. **20** (1913) 241; Van Dam, W., Z. physiol Chem. **79** (1913) 247; Mendel, L. B., and Blood, A. F., Journ. Biol. Chem. **8** (1910) 177; Long, J. H., and Barton, A. W., Journ. Am. Chem. Soc. **36** (1914) 2151; Sherman, H. C., and Neun, D. E., ibid. **38** (1916) 2199; Falk, Chemistry of Enzymes, Chem. Cat. Co. (1921); etc.

[3] Philip. Journ. Sci. § A **10** (1915) 1.

and digested 85 per cent of the casein of milk in thirty minutes when examined by Pratt in 1914. The dry material had been sealed up in small sample vials of glass and had lain in a pigeon-

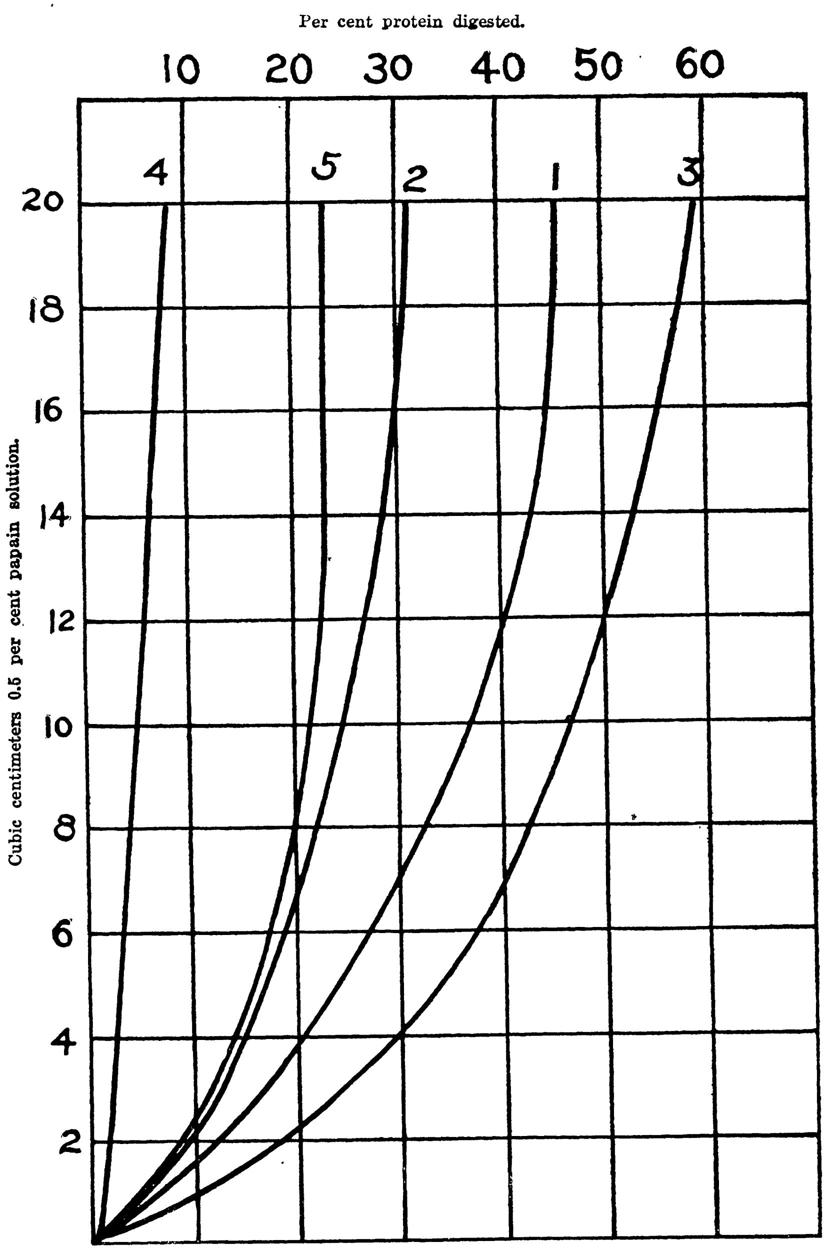

FIG. 1. Curves showing results of experiments with papain solution.

hole in the desk, protected from the sunlight most of the time since. Apparently papain may lose its activity with age, and this probably accounts for much of the inferior papain found in the market.

The papain used by us was furnished by the Bureau of Science, Manila, Philippine Islands.[4] The only deviation from Pratt's procedure introduced by us was the use of a 10 per cent solution of skimmed-milk powder as the substrate instead of the sweetened, condensed, skimmed milk. The milk powder is more readily handled and remains sweet for an indefinite period when open to the air. It was, therefore, substituted for the sweetened, condensed, skimmed milk which had been used by Pratt. Curve 1 is for sundried papain; curve 2, for alcohol-precipitated papain; curve 3, for alcohol-precipitated papain with milk that had been dialyzed at 20° C. for fourteen hours; curve 4, for alcohol-precipitated papain that had been dialyzed at 20° C. for fourteen hours; curve 5, for papain solution that stood at a temperature of 0° to 5° C. for seventeen hours.

Our results are in accord with those of Pratt, who found the alcohol-precipitated enzyme to be more active than the sundried material. Curve 4 was determined in the hope that a separation of the papain from any co-enzyme might be made by dialysis and the co-enzyme identified, and curve 3, that the mineral salts present in milk might be removed. Curve 3 shows greater activity than does any other curve in fig. 1. Curve 4 shows much less activity than curve 1. To determine whether the lessened activity was due to the removal of a co-enzyme or to a partial autolysis of the enzyme, the experiment shown by curve 5 and another (the curve for which is not included) were carried out. Curve 5 shows lessened activity of the enzyme, which indicates that the enzyme decomposes at a temperature as low as 0° to 5° C. in the presence of water. The unrecorded curve showed a maximum digestion of 10 per cent when a 0.5 per cent solution of papain is allowed to stand sixteen hours at a temperature of 15° C. This proves that the decrease in activity for curve 4 is due to the decomposition of the enzyme, probably by autolysis, and not by the removal of a co-enzyme.

[4] Mr. A. H. Wells, chief of the division of organic chemistry of the Bureau of Science, kindly furnished us with two samples, one sundried and the other alcohol precipitated. The latter was practically white. The alcohol-precipitated sample showed the greater digestive powers.

The curves in fig. 2 are the results from further attempts to dialyze papain solution: Curve 6, at a temperature of 16° to 19° C. for four hours; curve 7, at about freezing for sixteen hours; and curve 8, at a like temperature for twenty-four hours. Even for so short a time as four hours a great decrease in activity takes place at 16° to 19° C. Dialysis at temperatures near freezing was not successful, since decomposition of the enzyme took place, as is indicated by curve 5, fig. 1.

All the curves in fig. 3 are the results of using 10 cubic centimeters of 0.5 per cent papain solution with 25 cubic centimeters of 10 per cent solutions of skimmed-milk powder with varying quantities of salts or acids (see Table 1). The total volume of the mixture was equal to 50 cubic centimeters.

In as much as the literature relative to the influence of acids and bases on the digestive activity of papain is contradictory, it was thought to be worth while to investigate their influence and that of several salts.

The results of the latter investigation are set forth in fig. 3 and in Table 1.

TABLE 1.—*Influence of various compounds upon the activity of papain.*

Curve No.	Salt or acid solution.	Strength of salt or acid solution.	Concentration of salt or acid at point of maximum effect.		Casein digested at point of maximum effect.
		Per cent.	*Per cent.*	*Effect.*	*Per cent.*
6	NaCl	10	0.90	Activates	22
			[a]2.00	Inhibits	9
7	Na_2CO_3	3		Inhibits at once	26
8	$NaHCO_3$	4		do	8.5
9	$CaCl_2$ [b]	3		do	29
10	$MgSO_4$	4	0.32	Activates slightly	41
			[a]0.80	Inhibits slightly	38
11	H_3BO_3	2	0.32	Slightly inhibits at once	30
12	KCl	4	0.32	Activates	45
13	Na citrate	5	0.50	do	52
14	CH_3COOH	2.5	[a]0.50	Inhibits at once	6
15	$CH_3CHOH\ COOH$	5	[a]1.00	do	18

[a] Maximum concentration used.

[b] $CaCl_2$ substituted for $CuSO_4$ in the precipitation of the milk protein.

CONCLUSION

Autolysis of papain takes place at temperatures as low as 0° C. when the enzyme is put in water solution with toluene as an antiseptic. Air-dried samples in sealed glass containers

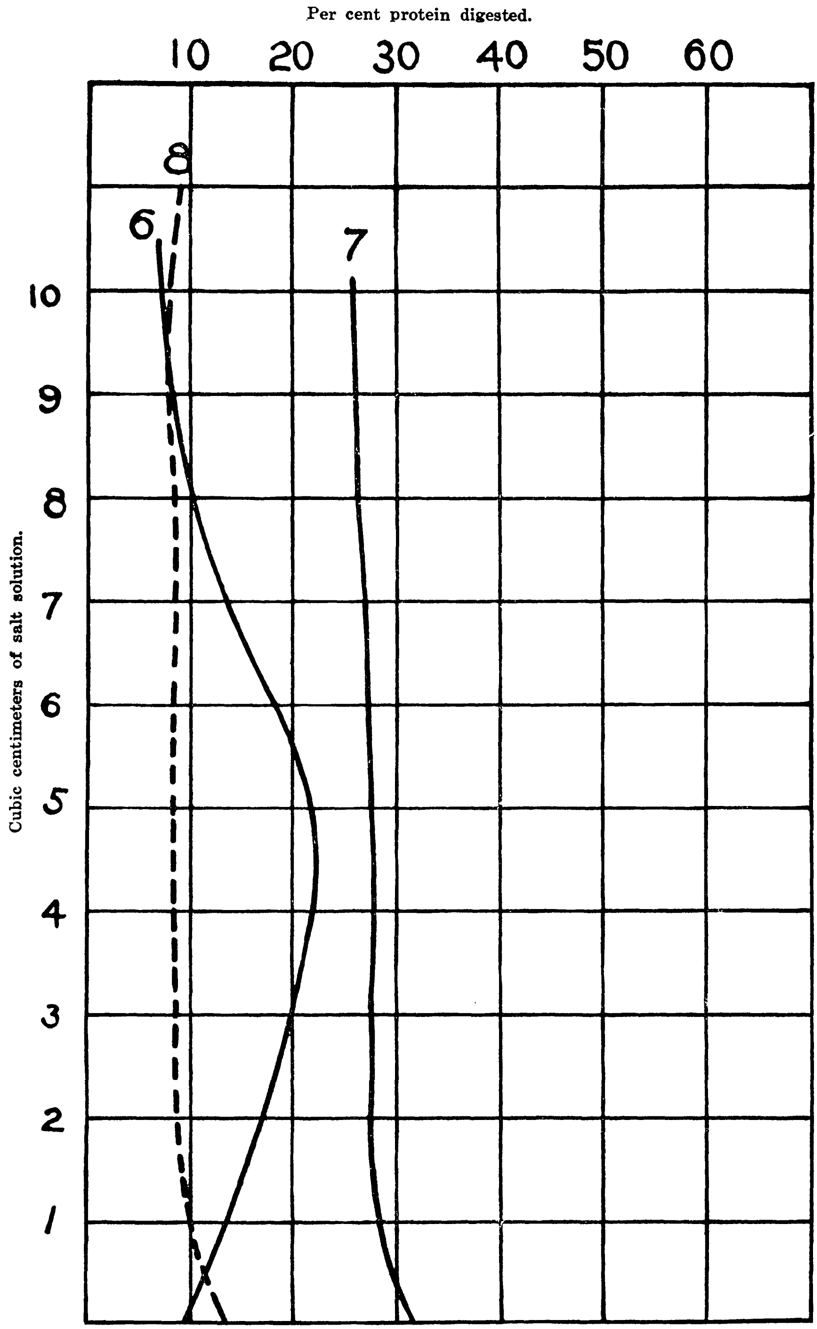

FIG. 2. Curves showing results of experiments with salt solution.

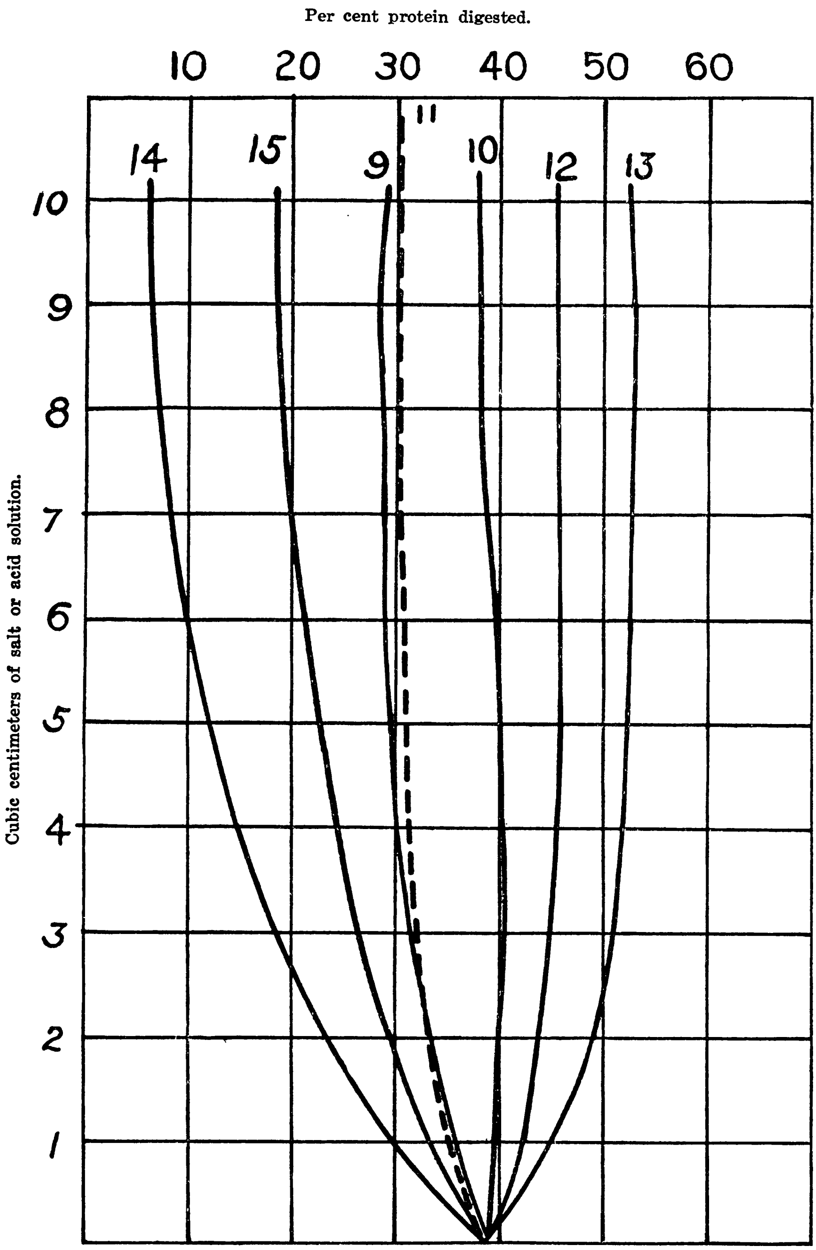

FIG. 3. Curves showing results of experiments with salt or acid solution.

had lost their activity at the end of seven years. Sodium chloride shows first a slightly activating effect, followed by an inhibiting effect in more-concentrated solutions. Sodium carbonate, sodium bicarbonate, calcium chloride, magnesium sulphate, and boric acid have no marked influence; potassium chloride and sodium citrate showed marked activating influence; while acetic acid and lactic acid, contrary to the findings of Vines [5] and of Mendel and Blood [6] with hydrocyanic, a weak organic acid, showed strong inhibiting effects.

[5] Am. Bot. 17 (1902) 606.
[6] Journ. Biol. Chem. 8 (1910) 182.

ILLUSTRATIONS

TEXT FIGURES

REVIEW OF PHILIPPINE PALEONTOLOGY

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SIXTEEN PLATES

INTRODUCTION

The study of ancient life in the Philippines has great economic value in connection with the stratigraphy of sedimentary beds containing coal and oil and with the associated strata. The relative geological age of rocks in a given district may be determined by a study of the order of deposition, if there have been no great disturbances such as faulting and intense folding; but such an ideal condition is seldom obtained. In the Philippines, in addition to the above-mentioned factors, a heavy cover of forest and high grass obscures the rocks, and the land masses are broken by deep seas. Partially to reassemble the shattered mosaic of the past, one must study the "Books of Rock" and their fossil contents. In this way only can the geological history be read and the patterns of Nature be deciphered. At best, the evidence will be incomplete but often after much labor a fairly complete outline of the design can be obtained.

For the benefit of the layman, it is necessary to state a few of the principles of paleontology, the study of ancient life. That the life of the present was evolved from the past is axiomatic in this study. Life through long geological ages has been continuous, and on this account such a discontinuous record as is evidenced in the succession of different rocks in a given area can only be interpreted by reference to this unbroken life line and to the fossil record in far distant regions. On account of this fossil record paleontological advances depend upon world-wide investigations by many workers, and a certain familiarity with this great world field is necessary for arriving at broad conclusions. Such extensive studies indicate that, once a species is extinct, this particular life form is never again repeated. This principle is particularly useful in picking out special fossils which indicate certain beds. These horizon determiners are

almost invariably extinct forms, and the determination of the geological time during which they lived can only be made after much collection in many localities. In general, these extinct forms are the highly organized ones which have developed special adaptations particularly suited for their immediate environment. A slight change in climate, food, or salinity may be sufficient to cause such forms to become extinct or to develop other habits. New habits quickly, geologically speaking, may cause specific changes and a new species may result. The recognition of such evolutionary series of forms makes it possible for the paleontologist to recognize comparatively small divisions of geological time, and its importance in oil and coal work is very great. In temperate latitudes these changes are marked; but recent work by the writer indicates that in the Tropics, where climatic changes have been but slight, evolution has proceeded much more slowly. As was stated above, the highly organized species make the best horizon determiners, and one fossil like *Vicarya callosa* Jenkins is of more value in horizon determination than several dozen others associated with this extinct but once widespread Asian species. Corals are highly specialized, and on this account they should prove particularly useful in the Philippines.

ECONOMIC USES OF PALEONTOLOGY

A few examples of the economic uses of paleontology will suffice to indicate that this study is important in practical explorations for certain highly useful substances. In California an oil company was starting a well on a supposed anticline (upfold). Sandstone on the west flank looked like the sandstone on the east, and the operators located approximately between the two flanks. A paleontologist examined the property, and he collected upper Cretaceous fossils from the west side and Miocene fossils from the east side, thus demonstrating that the oil operators were drilling not on the anticlinal axis but upon a great fault, an ancient break in the earth's crust, a very unlikely place for accumulation of oil. Long ago the Cretaceous strata had been moved upward hundreds of feet and the Miocene downward, faulting out all of the Eocene and Oligocene. This half hour's work by the paleontologist caused the operators to save thousands of dollars, as failure was certain in this spot.

For many years much time and money were spent in New York in search of coal, as the neighboring state, Pennsylvania, had an abundance. Hall, state geologist of New York, showed that the Paleozoic formations of New York were far older than

those of Pennsylvania and were deposited in deeper marine waters and not in the quiet waters of a low-lying coastal plain that characterized the conditions of deposition of the coal formations of Pennsylvania. This definite conclusion was reached only by a careful comparison of the fossil floras and faunas from the two states.

Paleontology is not merely of negative value, but is of great positive use in guiding exploration and in recognizing geological structures suitable for drilling. A small collection of fossils is obtained from a new locality and among them are certain horizon markers which are always associated with coal. At once the field is explored for this valuable fuel. In this way, the exploring oil or coal geologist is able to pick out likely areas, and he need not spend time in hopeless regions of volcanic rocks or barren sedimentary beds.

In oil-well drilling many times the bits bring up very small but determinative fossils, and sometimes the only evidence of the underlying structure is obtained in this way. Near Topila, Mexico, in the Anderson well, many small fossils were collected in this maner from a depth of 1,800 feet (550 meters). From a study of this fauna the writer concluded that the rocks containing this assemblage were upper Eocene in age and were essentially equivalent to beds outcropping in the United States Gulf region many kilometers distant but not exposed on the surface in that part of Mexico. This discovery indicated the probable depth of possible production in this territory and was economically important on this account.

Again, in a wild-cat well near Waldorf, California, the bit brought up several small fossil snails, all of the same species, from a depth of 2,000 feet (610 meters). These small snails, not over 1 centimeter long, proved to be *Bittium camulosensis*, a characteristic fossil of the San Fernando Pliocene. Now, the oil in this region generally occurs below this formation, well down in the Vaqueros of Middle Miocene age. The locators thought they started in the Miocene at the surface, but this indisputable evidence indicated that they were mistaken in this regard and either that they had still from 900 to 1,200 meters to go (an impossible depth for economic production) or that a great fault occurred near this well site! The well was abandoned.

As will be shown later in this paper, the fossil clams and snails occurring in the Tertiary enable us to correlate some of these beds with the oil-bearing horizons of Java and Sumatra. This correlation clearly indicates broadly that there are possibilities of economic production of petroleum in the Philip-

pines. In such a manner are broad geological explorations guided by paleontology.

Many volumes of Earth's Books of Rock are missing in the stratigraphic record of the Philippines, and of the individual books complete chapters are missing or so badly mutilated by subsequent earth movements—the geologic scribes—that their deciphering is extremely difficult. The Archaean and Paleozoic sets are entirely missing. Of this great library of Earth's Geologic History, only a small fragment of the Mesozoic set is known, and even in the Tertiary only the Miocene and Pliocene prints are fairly readable. Much of the Pleistocene volume, the last of this wonderful history, is yet to be pieced together, although it is fresh from the Graver's hands.

BRIEF REVIEW OF THE IMPORTANT PALEONTOLOGICAL LITERATURE

Baron Richthofen [1] first reported some interesting Foraminifera from Binangonan Peninsula and referred to them as *Nummulites* with an assignment of the beds yielding them to the Eocene. Later Abella [2] referred certain limestones in Cebu to the Eocene as they likewise contained supposed *Nummulites*. Felix Karrer [3] described some Foraminifera from Zambales Mountains and recognized the Miocene age of the tuffs yielding them. Martin,[4] in a very excellent paper, laid the first firm foundation for Philippine paleontology by recognizing *Vicarya callosa* Jenkins and its associated fauna in Miocene beds of Cagayan Valley and the vicinity of Aringay, La Union. His recognition of Pliocene in Agusan Valley on apparently very scanty evidence really indicated his great grasp of Malayan paleontology and geology. W. D. Smith [5] reviewed the question

[1] Richthofen, Ferdinand von, Vorkommen der Nummulitenformation in den Philippinen, Zeitschr. d. deutschen geol. Ges. **14** (1862) 357–360. Cf. Sobre la formacion numulitica del Japon y de Filipinas (1862).

[2] Abella y Casariego, Enrique, Rapida descripción física, geológica y minera de la isla de Cebu. Madrid, Tello (1886) 187, 6 pls., 1 map. Also Bol. de la Com. del Mapa geol. de España **13** (1886).

[3] Karrer, Felix, Foraminiferos de las margas terciarias de la isla de Luzon (Filipinas), Bol. de la Com. del Mapa geol. de España **7** (1880) 257–282, 2 pls.

[4] Martin, Karl, Ueber tertiäre Fossilien von den Philippinen, Samm. des geol. Reichs-Museums in Leiden **5** (1896) 52–69, 2 cuts. Translation, Becker, Geology of the Philippine Islands, Annual Rep. U. S. Geol. Survey **21** [3] (1901) 493–644. See also Orbitoides von den Philippinen, Centralbl. f. Mineral., Geol. u. Paleon. (1901) No. 11.

[5] Smith, Warren Dupré, Orbitoides from the Binangonan limestone, etc., Philip. Journ. Sci. **1** (1906) 203–209, 2 pls.

of the age of the Binangonan limestone and showed that the foraminiferal limestone did not contain *Nummulites* but larger species which he described as *Orbitoides*. Douvillé [6] referred these forms to *Lepidocyclina*. Smith [7] also recognized *Vicarya callosa* in the Batangas Peninsula and described several other forms associated with this guide fossil. Later this same writer [8] described more new fossils from the Philippines and figured some characteristic species. In an economic report by Pratt and Smith, Smith [9] determined the species in the various horizons and figured the species collected from the beds. Two years ago H. Yabe,[10] of the Tohoku Imperial University of Japan, published a careful discussion of *Lepidocyclina* of the Philippines and illustrated several new species of this genus most excellently. The present writer [11] recently discussed the Vigo fauna and its bearing upon the rate of evolution of Mollusca in the Tropics.

MESOZOIC

W. D. Smith [12] first recognized in certain cherts and slates in Ilocos Norte unicellular forms, Radiolaria, which appear to be of probable Jurassic, Middle Mesozoic, age. Concerning these rocks Smith says:

> In Ilocos Norte, Pangasinan, Balabac, Panay, and other localities there are outcrops of hard, red cherts or jaspers, in some places as hard, structureless bowlders and in others as fissile beds. When I first found these in Ilocos Norte, I compared them with the cherts of California. On examination with a microscope they were found to contain fragments of radiolarian tests. These rocks have a wide distribution in this part of the world, and have been provisionally assigned to the Jurassic by Martin.[13]

[6] Douvillé, H., Les foraminiféres dans le Tertiaire des Philippines, Philip. Journ. Sci. § D **6** (1911) 53–80, 4 pls.

[7] Smith, W. D., Preliminary geological reconnaissance of the Loboo Mountains of Batangas Province, Philip. Journ. Sci. **1** (1906) 617–633, 4 pls.

[8] Smith, W. D., Contributions to the stratigraphy and fossil invertebrate fauna of the Philippine Islands, Philip. Journ. Sci. § A **8** (1913) 235–300, 20 pls.

[9] Pratt, Wallace E., and Smith, Warren D., The geology and petroleum resources of the southern part of Bondoc Peninsula, Tayabas Province, P. I., Philip. Journ. Sci. § A **8** (1913) 301–376, 10 pls., 1 map.

[10] Yabe, H., Notes on Lepidocyclina limestone from Cebu, Science reports of the Tohoku Imperial University, Second series (Geology) **5** [11] (1919) 37–51, 2 pls.

[11] Dickerson, Roy E., A fauna of the Vigo group; its bearing on the evolution of marine molluscan faunas, Philip. Journ. Sci. **18** (1921) 1–23, 2 pls.

[12] Smith, W. D., Philip. Journ. Sci. § A **8** (1913) 245, 246.

[13] Martin, K., Reisen in den Molukken I. Leiden (1903) pt. 3.

In certain localities in Borneo rocks of proved Upper Cretaceous age rest uncomformably upon the older radiolarian beds, so it is clear that the upper possible limit, Lower Cretaceous, is fixed for these cherts. Hinde [14] compares the species of Radiolaria with radiolarian faunas elsewhere and concludes that their age is Jurassic.

Smith reports the same rocks from the western cordillera of Panay and from Bulacan Province, Luzon. At the latter place he made slides from material collected by Mr. Frank A. Dalburg and recognized the Radiolaria *Cenosphaera affinis* Hinde and *Dictyomitra tenuis* Hinde. The photomicrographs given in Plate 1 illustrate these interesting marine forms.

Similar forms have been described by Hinde in the appendix to Molengraaff's Explorations in Borneo.

The stratigraphic evidence of the relative age of these rocks in the Philippines is lacking, but the geographic distribution of similar rocks in the Moluccas and Borneo indicates that they all represent the same period. Unfortunately the Radiolaria have a rather great geological range and on this account only a tentative assignment to the Jurassic is possible.

No Cretaceous rocks have been recognized in these Islands, although the Cretaceous is well developed in Japan.

TERTIARY

The lowest portion of the Tertiary, the Eocene—the dawn of modern life—has also not been recognized with certainty in the Philippines, although rocks of this age occur in Japan to the north and Java to the south.

The genus *Nummulites* in many regions is characteristically Eocene, but in the East Indies this genus is not so restricted. The type locality of *Nummulites subniasi* Douvillé is in limestone associated with coal measures of Batan Island. This form, according to Douvillé, is equal to *Nummulites variolaria* Brady from Nias Island, which is located near the west coast of Sumatra. This species, according to Brady, is associated with *Nummulina ramondi, Orbitoides papyracea,* and *Orbitoides dispansa,* in Sumatra. The form identified by Brady as *Orbitoides papyracea* was later shown to be distinct from this species and

[14] Hinde, G. J., Appendix on fossil Radiolaria of Central Borneo in Molengraaff, G. A. F., Geological explorations in Central Borneo. Society for the Promotion of the Scientific Exploration of the Dutch Colonies, Leyden (1893–94).

on this account was described under the name of *Lepidocyclina verbeeki* by Newton and Holland.[15]

Lepidocyclina verbeeki Newton and Holland occurs in the upper limestone above the coal in Cebu, a horizon of probable Miocene age. Thus it is that the general association and connections of *Nummulites subniasi* Douvillé are not with Eocene species but with Miocene.

That Eocene beds may be present is a possibility, but as yet they have not been recognized. Likewise, horizons of Oligocene age are not positively known. In certain localities, Eocene and Oligocene times are represented by a mere line of unconformity between the basement complex of diorites and associated schists and the sedimentary rocks of Miocene age. In other words, a portion of the Philippines was a land mass during Eocene time, and on this account no marine sedimentary beds of Eocene age occur in certain regions.

MIOCENE

VIGO GROUP[16]

Rocks of Miocene age have been recognized in most of the larger islands of the Philippines, and owing to their widespread occurrence this period of the Tertiary is best known. Since both oil and coal occur in these rocks, their paleontology is of particular economic importance. The rocks of the Vigo group exhibit two pronounced faunal facies. One occurs in limestone and is characterized by large unicellular forms, Foraminifera of the genus "Lepidocyclina," while the other facies consists principally of clams and snails which lived in the sandy or muddy, moderately deep waters of an inland Miocene sea.

PELECYPODS AND GASTROPODS OF THE VIGO GROUP, SANDSTONE AND SHALE FACIES

The pelecypods and gastropods of the Miocene are best known from Bondoc Peninsula, Luzon Island. At many places in the

[15] Newton and Holland, On some Tertiary Foraminifera from Borneo, Ann. & Mag. Nat. Hist. VII 7 (1901) 215.

[16] The writer is not in agreement with Pratt and Smith concerning the stratigraphic relations of the Malumbang, Canguinsa, and Vigo in their type localities, the Bondoc Peninsula. He believes that a great unconformity exists between the Malumbang and the underlying Vigo group. He failed to recognize an unconformity between the Canguinsa formation and the Vigo shale, although the areas cited by Pratt and Smith were critically examined. The relations that appear at these places are best explained by faulting. On this account the term "Vigo" is widened to include the Canguinsa formation as its upper sandstone facies, thus raising the term Vigo to a group rank.

southern half of this peninsula excellently preserved fossils have been collected from the Canguinsa formation, the upper horizon of the Vigo, and from the underlying shales of this group. A partial list of these species follows.

Partial list of species from the Vigo group.

Architectonica pictum (Philippi).
Actaeon reticulatus K. Martin.
Buccinium simplex K. Martin.
Bullaria ampulla (Linnæus).
Cancellaria crenifera Sowerby.
Cancellaria elegans Sowerby.
Cassidaria.
Cerithium jenkinsi K. Martin.
Cerithium herklotsi K. Martin.
Cerithium moniliferum Kiener.
Cerithium bandongensis K. Martin.
Cerithium sp. nov.
Cerithium jonkeri K. Martin.
Cerithidea cf. *ornata* Hinds.
Cerithidea (*Pyrazus*) cf. *sulcatus* Bruguiere.
Cerithidea cf. *quadrata* Sowerby.
Conus ornatissimus K. Martin.
Conus sp. nov.?
Conus sp.
Conus lividus Hwass.
Conus loroisii Kiener.
Conus hardi K. Martin.
Conus striatellus Jenkins.
Columbella bandongensis K. Martin.
Cyclonassa elegans Kiener.
Cypraea cf. *tigris* Linnæus.
Cypraea sp.
Drillia sp.
Delphinula?
Delphinula reeviana Hinds.
Distortio clathrata Lamarck.
Eburna ambulacrum Sowerby.
Ficus reticulata (Lamarck).
Haminea.
Harpa articularis Lamarck.
Mitra javana K. Martin.
Mitra cf. *jenkinsi* K. Martin.
Mitra junghuhni K. Martin.
Mitra bucciniformis K. Martin.
Mangelia.
Murex endivia Lamarck.
Marginella.
Melania asperata Linnæus.
Melania asperata inquinata Quadras.
Nassa crenulata (Bruguiere).
Nassa dispar Adams.
Nassa gemmulata (Lamarck).
Nassa globosa minor Quoy.
Nassa thersites immersa Carpenter.
Nassa thersites leptospira (Bruguiere).
Nassa quadrasi Hidalgo.
Nassa canaliculata Lamarck.
Nassa costellifera A. Adams.
Nassa reussi K. Martin (may = *N. costellifera*).
Natica albumen Lamarck.
Natica?
Natica spadicea Reeve.
Natica mamilla Lamarck.
Natica lacernula d'Orbigny.
Natica cumingiana Recluz.
Nerita funiculata Reeve.
Olivella.
Phos roseatus Hinds.
Ranella.
Ranella subgranosa Beck.
Ranella tuberculata Broderip.
Ricinula spectrum Reeve.
Rostellaria fusus Linnæus.
Rostellaria crispata Kiener.
Strombus canarium (Linnæus).
Strombus, sp. a.
Strombus, sp. b.
Strombus swainsoni Reeve.
Strombus (?) *fusus* K. Martin.
Strombus (?) sp.
Turris (*Surcula*) *flavidula* Lamarck.
Turris garnonsi Reeve.
Turris deshayesi (Doumet).
Turris carinata woodwardi K. Martin.
Turris coronifer (K. Martin).
Turris marmorata (Lamarck).
Terebra bicincta K. Martin.

Partial list of species from the Vigo group—Continued.

Terebra javana K. Martin.
Terebra.
Triton pfeifferianum Reeve.
Trochus.
Telescopium telescopium Linnæus.
Trivia smithi K. Martin.
Voluta cf. *innexa* Reeve.

PELECYPODA

Arca cornea Reeve.
Arca ferruginea Reeve.
Arca granosa Linnæus.
Arca cf. *coelata* Reeve.
Arca tenebrica Reeve.
Barbatia fusca (Bruguiere).
Cardium.
Cardium attenuatum Sowerby.
Cardium donaciformis Cuming.
Cardium unicolor Sowerby.
Cardita antiquata Linnæus.
Chione chlorotica Philippi.
Chione?
Corbula scaphoides Hinds.
Corbula socialis K. Martin.
Clementia hyalina Philippi = *C. papyracea.*
Dosinia cf. *lenticularis.*
Dosinia cretacea Philippi.
Glycimeris viteus (Lamarck).
Glycimeris angulatus (Lamarck).
Ostrea.
Paphia textrix Deshayes.
Pecten (*Pleuronectia*) *pleuronecta* Linnæus.
Pecten cf. *radula* Linnæus.
Pecten cf. *pseudolima* Sowerby.
Pecten pseudolima Sowerby.
Pecten cf. *cristularis* Adams and Reeve.
Placuna placenta Linnæus.
Psammobia cf. *lessoni* Blainville.
Psammobia sp.
Pinna sp.
Solen sp.
Spisula sp.
Solecurtus quoyi Deshayes.
Spondylus sp.
Tellina sp.
Tellina sp.
Vermetus javanus? K. Martin.
Vermetus sp. nov.

In the above list about 75 per cent of the specifically determined forms are living species, an astonishing percentage when the geologic history of the region yielding these forms is considered. The extinct forms are practically all common to the upper Miocene of Java according to K. Martin,[17] and they are practically all highly organized species. Such highly developed species are particularly fitted to their surroundings, and a slight change in life conditions might cause the extinction of the species or bring about a specific change.[18] As was noted above, the percentage of Recent species is remarkably high, and it is the writer's conclusion from a detailed study of the subject that the evolution of marine molluscan faunas in the Tropics is far slower than in the Temperate Zones. On this account the same "yardstick" in the Tertiary geological time scale cannot be applied in both tropical and temperate regions. The scale used in the Temperate Zones is approximately as follows: Eocene, 0 per cent living species but practically all genera living; Oligocene, 3 per

[17] Martin, K., Tertiärschichten auf Java. Leiden (1880) 44–51.

[18] Dickerson, R. E., Philip. Journ. Sci. 18 (1921) 1–23. This subject is discussed in detail in the paper cited.

cent living species; Miocene, 25 per cent; Pliocene, 60 per cent; Pleistocene, 90 per cent. It is the writer's opinion that this percentage scale in the Tropics must be considerably widened.

On this account the careful determination of guide fossils is of great economic importance. Good guide fossils are far more difficult to select in connection with tropical Tertiary faunas of the Philippines than in the California Tertiary, owing to the great predominance of Recent Mollusca. As will be seen from a study of the fauna cited above, most of the forms which are extinct were originally described from a correlative horizon in Java. Of these, the writer is inclined to think that *Cerithium jenkinsi*, *C. herklotsi*, *C. bandongensis*, *Mitra javana*, *M. jenkinsi*, *M. junghuhni*, *M. bucciniformis*, *Turris coronifer*, *Terebra bicincta*, *T. javana*, *Vicarya callosa*, and *Vermetus javanus* will probably prove reliable guides among the Mollusca. These species are all representatives of highly organized genera, and their extinction during post-Miocene time was probably due to their inability to obtain life conditions suited to their highly specialized needs.

Corals, echinoderms, and the more highly organized Foraminifera will probably prove to be even better horizon determiners, but their comparative infrequence in strata of the Philippines will at times preclude their use. The writer has not yet attempted to identify the corals and the echinoderms in the collections made, but their value will no doubt prove to be great. It seems that their rate of evolution may have been greatly retarded, but much study will be required in this connection. For stratigraphic work in the Tropics large and complete collections are necessary for obtaining results of much value, in as much as the geologic and paleontologic history, even with the best data available, is read with much difficulty. Much comparative material, both Recent and fossil, should be accumulated, as subspecific differences will be recognized only through comparative studies. These subspecific differences are exceedingly important for minute separation and discrimination of strata deposited under tropical conditions.

Some of the most abundant species and guide fossils for the sandstone and shale facies of the Vigo are illustrated in Plates 2 to 10.

LEPIDOCYCLINA LIMESTONE FACIES OF THE VIGO GROUP

The limestones of the Vigo group are characterized by the abundance of the large foraminifer *Lepidocyclina*, associated with other Foraminifera. This limestone is in certain places

stratigraphically associated with sandstones and shales which have yielded a typical Vigo fauna. The best region for the study of this facies is in Cebu Island, where the limestone which overlies the coal at Danao has yielded several species of these interesting and important unicellular forms. According to Douvillé,[19] these beds represent the middle horizon. Douvillé states that the study of Foraminifera permits him to make the following subdivisions:

I. The lower lignitic horizon is characterized by the association of genera *Nummulites* and *Lepidocyclina.*

II. The middle horizon is characterized by the abundance of *Lepidocyclina* and the presence of *Alveolina.*

III. The upper horizon has an abundance of small *Lepidocyclina* and *Miogypsina.* Douvillé states that this same succession occurs in Borneo and Indo-Asia. He correlates the lower horizon with the Stampian, Oligocene; the middle, with the Aquitanian, Lower Miocene; the upper, with the Burdigalian, Miocene. In a footnote Douvillé states that in conformity with recent work the limit between the Oligocene and the Miocene, or between the Eogene and the Neocene, is placed between the Stampian and Aquitanian, properly limited. Douvillé's conclusions, translated by Mrs. G. B. Moody and Mrs. R. E. Dickerson, are as follows:

From the preceding study the writer is enabled to classify the described beds in the following manner:

Eogene (comprising the Eocene and the Oligocene), Stampian Stage.

Limestone of Caracaran (Island of Batan, locality 2).

This is a bluish gray limestone upon which the Foraminifera stand out in black; it is a part of the lignitic horizon and is intercalated between beds of lignite.

The thin plates and polished sections show a small species of *Nummulites* 2.7 millimeters in diameter which appears to correspond to *N. niasi* Verbeek; but this last species is microspheric while that of the Philippines is macrospheric, and has been distinguished as *N. subniasi.* This same limestone also yields *Polystomella* sp. and a curious *Lepidocyclina* belonging in the section *Neophrolepidina, L. smithi,* which resembles certain varieties of *L. proemarginata.*

The coexistence of *Nummulites* and *Lepidocyclina* characterize the Stampian; it is noteworthy that these two genera are not represented here except by forms of very small size, although a little farther south in Borneo the large forms are abundant.

II. Neocene (Aquitanian, Burdigalian, Helvetian) Aquitanian Stage.

1st. The soft yellowish sandstone of Sibul Gulch (old Alpaco mine, Island of Cebu, locality 273). The sandstone is incoherent and but slightly

[19] Douvillé, H., Les Foraminiféres dans le Tertiaire des Philippines, Philip. Journ. Sci. § D 6 (1911) 54.

cemented by limestone. The fossils are casts and the internal characters are difficult to recognize. The fauna is essentially composed of *Orbitolites* and *Alveolinella*, with *Operculina costata* var. *tuberculata*, *Rotalia*, *Polystomella*. This bed is indicated as above the coal and below the *Lepidocyclina* limestone. This ought to correspond nearly to the horizon with *Orbitolites* and *Alveolinella* in Java which Mr. Verbeek places as stage m, that is to say, in the lower Aquitanian. Owing to the poor state of preservation of the fossils, this reference is only a provisional one. It is to be noted that Professor Martin announced the discovery by Semper of *Orbitoides* in a mine of Alpaco.

2d. The best characterized horizon is the limestone with the large lepidocyclinas:

Limestone of Guila-Guila (Cebu, locality 278). There occur numerous lepidocyclinas of large size; some present surfaces having well-developed tubercules and these have been referred to *Lepidocyclina insulæ-natalis;* the others with but few if any tubercules have been assigned to *Lepidocyclina richthofeni*. These two forms are very numerous; they are associated with a third species, a much smaller form composed of a central part, very swollen, bordered by a collarette; this is *L. formosa*, nearly free from tubercules, but it presents very thick walls between the chamberlets. These various forms are often found free.

There are places representing this same horizon, the limestones of the Barrio of Mesaba (Cebu locality 272) *L. insulæ-natalis;* those of the valley of Cumajumayan (Cebu locality 28) *L. richthofeni* and *L. formosa;* the two latter forms occur together with a third species, *L. inermis*, which has thin walls between its cells, at Compostela mine (Cebu, locality (289).

3d. There is another horizon probably to be placed slightly higher, a soft limestone bed, cream white in color, which outcrops boldly in great escarpments along the road from Toledo to Cebu, on the edge of the Minanga River (locality 277, near camp 1); this presents upon its surface very well-preserved specimens of *Operculina complanata* and *Cycloclypeus communis;* this bed is correlated with the Silex marls of the Aquitanian of Borneo.

Burdigalian Stage.

This upper horizon is characterized by the appearance of *Miogypsina* and by the abundance of small lepidocyclinas of the section *L.* (*Nephrolepidina*) *verbeeki*. I refer the two following beds to the Burdigalian:

A very soft sandy yellowish limestone of Gaba Bay, Island of Batan (locality 8) above the lignitic beds; there occur well-preserved but fragile forms, among which are *Globigerina*, *Cycloclypeus communis*, *Amphistegina* cf. *mamillata*, and a small *Miogypsina*, the last being referred to a Burdigalian form occurring near Dax (France).

A very soft white limestone which runs along the Cordillera Central of the Island of Cebu, Valley of Cotabato (locality 279); here occurs *L. verbeeki*, which was first described by Mr. Warren D. Smith, but above all it is associated with *L. inflata* and numerous *Miogypsina irregularis*.

Of these three faunas which I recognized, the second is characterized principally by the great abundance of large *Lepidocyclina* which has a very great distribution from Madagascar to the Philippines. I recognized in my study upon the Foraminifera of the Tertiary of Borneo that they correspond to the Aquitanian; I have distinguished three horizons, E, F, G, which it ought to be possible to find in the Philippines when geological explorations are more advanced.

The upper horizon Burdigalian H (of Borneo) also presents a very great distribution; it is well developed in the island of Nias, near Java, from whence comes the type of *L. verbeeki*, and from Borneo where I have not been able to distinguish this species from the similar European form *L. tournoueri*. This same horizon appears to extend to the north in Formosa and Japan in the environment of Tokyo. This last locality is in latitude 36°, that is to say, near that of Gibraltar; however, the *Lepidocyclina* occur in France nearly to latitude 44° and beyond 45° in Italy.

The following table summarizes the references which I recognize:

Philippines.			Borneo.	
II.	Upper limestones with small Lepidocyclinas.	L. verbeeki, Miogypsina, Cycloclypeus communis	H.	Burdigalian.
	Middle limestone	Cycloclypeus communis; Operculina complanata	G.	Aquitanian.
	Lower limestones with large Lepidocyclinas.	L. insulæ-natalis	F.	
		L. richthofeni; L. formosa	E.	
I.	Lignitic horizon and lower limestones with Nummulites.	Nummulites subniasi; Amphistegina niasi; Lepidocyclina smithi	D.	Stampian.

In Europe the succession of faunas is very analogous; the lepidocyclinas are well developed, moreover, likewise in Spain, as well as Italy, where they attain a great size and are associated as in Borneo with reticulated *Nummulites*. The section of which *Lepidocyclina dilatata* is an example corresponds to the Asiatic section of *L. insulæ-natalis* and extends into the Aquitanian. Moreover, in the upper beds the section of *L. tournoueri* is represented by that of *L. verbeeki*. With these two are associated, moreover, *Miogypsina*.

The European basin and the Asiatic basin appear to have been completely separated at the end of the Eocene by the uplift of Lybia which was developed across the Mésogée and separated the Mediterranean from the Indian Ocean. It is only during very recent time that the Red Sea has almost reëstablished a communication between the two seas, but the waters of the Indian Ocean are even now several kilometers separated from the Mediterranean by the slight barrier of the Isthmus of Suez.

The limestones referred by Douvillé to the Stampian, as stated by him, occur between coal seams in Batan Island. At this locality or in its near vicinity in the gray shale overlying the East Batan coal seam in the Perseverancia claim very excellent specimens of *Vicarya callosa* Jenkins and numerous species of *Corbula* were obtained by Mr. F. A. Dalburg (Bureau of Science locality 7). *Vicarya callosa* Jenkins is regarded by Martin and other workers as being one of the best horizon markers of Middle and Upper Miocene in the East Indian islands. In this connection Smith states: [20]

[20] Smith, W. D., Philip. Journ. Sci. § A 8 (1913) 268.

This species is moderately common in the Philippine coal measure shales, being especially plentiful in the shale above the principal coal seam on the eastern end of Batan Island, Albay Province. It is also found in the same position in the coal measures in Cebu and Mindanao.

On this account it seems to the writer that the above reference to the Oligocene is very questionable, and it is his opinion that this Batan coal is of essentially the same age as is the coal of Cebu and tunnel 14 of Sibuguey Peninsula, Mindanao. At the latter place, Mr. F. A. Dalburg recently collected splendid specimens of *Vicarya callosa* Jenkins from the coal seams and shales. (See Plate 6, fig. 1*a*.) Now *Vicarya callosa* is associated with the coal seams of Cebu and seems to be a form which flourished in brackish water. Whether this form is very limited in geologic range is probably open to question, as those forms which have a great geographic distribution frequently have a considerable stratigraphic range as well. It is probably limited to the Vigo group at least, that is, to about 3,000 feet of sedimentary beds, as it never has been reported from the Malumbang formation.

Douvillé places locality 272 in his II, 2, the *Lepidocyclina* limestone. The Bureau of Science possesses an excellent collection of gastropods and pelecypods from this place, and the following forms have been identified:

Bullaria ampulla (Linnæus).
Conus sp.
Cerithium (*Campanile*) sp.
Cerithium sp.
Cerithium jenkinsi K. Martin.
Cerithium herklotsi K. Martin.
Cypraea sp.
Chione lacerata Hanley.
Fusinus sp.
Natica sp.
Lucina sp.
Pecten cf. *lentiginosus* Reeve.
Pecten leopardus Reeve.
Plicatula imbricata Menke.
Turbinella junghuhni K. Martin.
Trochus sp.
Turbo sp. a.
Seraphs sp.
Vicarya callosa Jenkins.
Voluta innexa Reeve.

A brief comparison of these forms with collections from the Vigo group of Bondoc Peninsula clearly demonstrates essential faunal unity.

W. D. Smith [21] reported some of the large foraminifers from Bondoc Peninsula from beds of Canguinsa age. He says:

The limestone from Mount Morabi (fossil locality 62) contains *Cycloclypeus communis* K. Martin, which represents the middle Miocene, and large lepidocyclinas some of which are 45 millimeters in diameter and 5

[21] Pratt, W. E., and Smith, W. D., Philip. Journ. Sci. § A 6 (1913) 330.

millimeters broad in the thickened central portion. * * * This species has been referred by Douvillé to the lower Miocene.

This *Lepidocyclina* fauna occurs in the upper portion of the Vigo group, the Canguinsa formation. This formation, in this same region, has yielded a large part of the mollusks reported above, and it is clear that the vertical range of the large representatives of the genus *Lepidocyclina* is much greater than Douvillé suspected.

H. Yabe,[22] in a recent publication, recognizes this possibility and he reviews the case as follows:

> L. Rutten studied foraminiferal rocks from southern and eastern parts of Borneo and found it necessary to modify somewhat H. Douvillé's correlation of the Tertiary rocks, because *Lepidocyclina* appeared to him to have a more extended vertical range than was believed by Douvillé. Thus the oldest Miocene and Oligocene deposits, according to Rutten are characterized by Lepidocyclinas of larger and smaller sizes, while the smaller ones alone are found together with Miogypsina in all parts of Miocene deposits except the lowest division.

Rutten [23] presents a table in his paper which is copied by Yabe. Yabe,[24] in another and later paper upon the *Lepidocyclina* limestone from Cebu, recognized *Lepidocyclina* (*Nephrolepidina*) *angulosa* Provale associated with *Lepidocyclina monstrosa* Yabe, *Lepidocyclina formosa* Schlumberger, and several other Foraminifera. It is evident from this assemblage that the section *Nephrolepidina* is not restricted to the uppermost horizon, as Douvillé thought.

Briefly, in conclusion, then, the *Lepidocyclina* limestone is equivalent to the shales and sandstones of the Vigo group, and the molluscan faunas of the latter beds are equivalent to the large-sized *Lepidocyclina* fauna of Cebu. In other words, the limestones, shales, sandstones, and coal are different depositional facies within the same group, the Vigo of probable Middle and Upper Miocene age.

The corals of the Vigo group are not well known, and many forms await careful description. In general, the corals of this group are either individual or slender branching forms, and this

[22] Yabe, H., Notes on a Carpenteria limestone from B. N. Borneo, Science Reports Tohoku Imperial Univ. II 5 [1] (1918) 2.

[23] Rutten, L., Studien über Foraminiferen aus Ostasien, Samml. d. Geol. Reichsmuseum I 9 (1911–1914) 287.

[24] Yabe, H., Notes on a Lepidocyclina limestone from Cebu, Science Reports Tohoku Imperial Univ. II 5 [2] (1919) 1.

characteristic is in great contrast with the coral fauna of the overlying Malumbang formation where the dominant forms are the large reef-building types with many large heads.

Smith [25] reports *Pattalophyllia* (?) *bonita* Smith, *Pachyseris cristata* K. Martin, and *Madrepora duncani* Reuss (?) from Bureau of Science locality 272, Barrio Mesaba, near Danao, Cebu, where they are associated with the large forms of *Lepidocyclina* and the Mollusca listed above from the same locality. *Pachyseris cristata* and *Madrepora duncani* are reported by Martin from locality P, where they are associated with *Vicarya callosa* and its characteristic molluscan associates.

FAUNA OF THE MALUMBANG FORMATION

Like the Vigo group, this formation of probable Pliocene age is very widespread throughout the Philippine Archipelago. Both lithologically and faunally this formation is in sharp contrast with the Vigo described above. The Malumbang corals, for example, are nearly all reef builders, colonial forms, while the Vigo corals are chiefly simple individual or slender branching forms. In the case of the Malumbang, these large colonial forms make the coralline limestone which is characteristic of this formation at its type locality, the Malumbang Plain and Banaba Ridge vicinity in the southern end of Bondoc Peninsula, Tayabas Province, Luzon. Since this formation is best known at its type locality, most of the present discussion is based upon material secured from that region. Pratt and Smith [26] discuss the Malumbang fauna at the type locality of the formation and give lists of species which the present writer has slightly modified. They state conditions as follows:

> All three horizons in the Malumbang series are fossiliferous. Fossils were collected at two places on the hills at the northern edge of Malumbang Plain, which are capped by the Upper limestone. Specimens from fossil locality 61 were obtained on the hills north of Mount Anuing near the eastern rim of Canguinsa River valley at Bacau, and others (fossil locality 63) were found on the hills immediately to the east on the northern border on Malumbang Plain. The Upper limestone in this vicinity is sandy, and grades imperceptibly into the Cudiapi sandstone below it. The fossils are embedded in sandy, calcareous material which might be designated either as sandstone or limestone.

[25] Smith, W. D., Contributions to the stratigraphy and fossil invertebrate fauna of the Philippine Islands, Philip. Journ. Sci. § A 8 (1913) 285–291.

[26] Pratt, W. E., and Smith, W. D., The geology and petroleum resources of the southern part of Bondoc Peninsula, Tayabas Province, P. I., Philip. Journ. Sci. § A 8 (1913) 325–327.

Fossils collected at locality 61.

Pecten senatorius Gmelin. +
Pecten leopardus (?) Reeve. +
Cytherea sp.
Cardium sp.
Schizaster subrhomboidalis Herklots.
Xenophora dunkeri K. Martin. (?)
Turbo sp.
Conus sp.
Pecten senatorius Gmelin. +
Mitra sp.
Xenophora sp.
Spondylus imperialis Chem. +
Operculina costata d'Orb. +
Conus sp.
Olivia indet.
Strombus labiosus Gray. +
Melania sp.
Dosinia sp.
Lagenum multiforme K. Martin var. *tayabum* Smith.
Turbo sp.
Trochus sp.
Bulla ampulla Linn. +
Olivia sp.
Pattalophyllia sp. +

Of the determinable fossils in these and the following lists, those which represent living species are indicated by a plus sign.

Fossils were obtained from the Cudiapi sandstone at three different places, as follows: (1) Fossil locality 65, calcareous sandstone immediately beneath the Upper limestone in the hills north of Malumbang Plain, adjacent to fossil locality 61; (2) fossil locality 4, calcareous sandstone beneath the Upper limestone about 450 meters south of Balinsog Hill, at an elevation of 360 meters; (3) fossil locality 13, sandstone, at an elevation of 270 meters on the high ground between Apad and Milipilijuan Creeks, affluents of the Bahay River. The Upper limestone does not occur over the sandstone at this place, but the sandstone itself is very calcareous.

The fossils from the Cudiapi sandstone were determined as follows:

From fossil locality 65.

Dosinia sp.
Pecten sp.
Schizaster subrhomboidalis Herklots.

From fossil locality 4.

Turbo sp.
Nassa sp.
Fusus sp.
Pleurotoma sp.
Melania sp.

From fossil locality 13.

Clementia sp.
Xenophora dunkeri K. Martin.
Ostrea orientalis Chemnitz. (?) +
Pecten senatorius Gmelin. +
Cerithium herklotsi K. Martin.
Pleurotoma tjemoroënsis K. Martin.
Pleurotoma carinata Gray. +

Fossils from limestone at a horizon corresponding stratigraphically with that of the Lower limestone were collected at three localities, namely: Fossil locality 44, at the mouth of Ayoni [Yuni] River; fossil locality 59, on a prominent hill (elevation, 250 meters) 2 kilometers west of Tala; and fossil locality 25, near Tambo, a barrio of San Narciso. However, as will appear in the discussion of the field relations at these localities, only the last group in the foregoing list represents certainly the Lower limestone; the fossils from the other localities may belong to either the Upper or Lower limestone.

On the north side of Ayoni [Yuni] River near its mouth, fossils were found in the limestone which forms the ridge along the western coast of the peninsula.

Fossils collected at locality 44.

Cypraea sp.
Arca nodosa K. Martin. (?)
Schizaster sp.
Cerithium sp. large internal cast.

Along the western coast from Ayoni [Yuni] north to Catanauan, this limestone is found in the coastal ridge, and occurs conformably only a short distance above beds which clearly belong to the Vigo shale. A short distance inland from Ayoni similar limestone occurs above the Canguinsa sandstone, and is overlain at places by the Cudiapi sandstone. This relation suggests that the limestone at Ayoni is the Lower limestone, but the evidence is not conclusive and either limestone horizon may be represented by the fossils from this locality.

Fossils collected at locality 59.

Pyrula gigas K. Martin.
Balanus sp.
Pecten leopardus K. Martin.

The limestone in which these fossils were found occurs on the top of a hill; below the limestone, with a concealed interval between, the Canguinsa sandstone was observed. The thickness of the concealed beds is hardly great enough to include the Cudiapi sandstone and the Lower limestone in their usual thicknesses. The fossils, therefore, are assigned to the Lower limestone, although they may represent the Upper limestone instead.

A sample of limestone (fossil locality 25), which certainly came from the Lower limestone horizon, was collected near the Cabongahan-San Narciso trail at an elevation of 180 meters, on the east side of the ridge extending northwest from Mount Cambagaco. Thin sections of this rock show small fragments of limestone and the well-known alga, *Lithothamnion ramosissimum* Reuss, intermingled in a cement of calcite.

The molluscan fauna of this formation is very sparse when compared to that of the Vigo group. This is in part due to poor preservation (as the surface waters readily penetrate the coralline limestones, marls, and sandstones) and in part due to original life conditions of deposition. The molluscan fauna living on coral reefs in these Islands to-day is not characterized by a great variety of forms, and since much of the sediment of the Malumbang was laid down as Pliocene coral reefs the molluscan assemblages found in these coralline limestones or their derivative marls consist of relatively few species.

State of preservation is no guide at all in determining the age of faunas in the Philippines. Vigo forms are often as well preserved as is beach material, while the much younger Malumbang fossils are frequently badly decomposed. Even Pleistocene species secured from raised coralline limestone beaches are much older in appearance than Vigo forms. On this account, the field man should be especially careful not to permit state of

preservation to influence his judgment in determining the relative age of any stratum he may study.

The best collecting locality yet found in the Malumbang was discovered by Mr. E. W. McDaniel, who assisted the writer in making a good collection here. This locality is described as follows:

Locality 1x, Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, west side of Ragay Gulf, 2.75 kilometers northwest of Bureau of Lands bench mark No. 1, in coarse sandstone (coral and shell sand) dipping 12° south, strike north 50° west. Collectors, E. W. McDaniel and Roy E. Dickerson.

The following species have been identified from this locality. The species still living in these seas to-day are marked by L.

Partial list of species from locality 1x.

Fungia sp.
Schizaster subrhomboidalis Herklots.
Clypeaster sp. a.
Clypeaster sp. b.
Arca ferruginea Reeve. L.
Arca cornea Reeve. L.
Arca sp.
Aspergillum annulosum Deshayes. L.
Cardium sp.
Cardita antiquata Linnæus. L.
Dosinia variegata Reeve. L.
Glycimeris sp.
Glycimeris multistriatus (Deshayes). L.
Modiolus sp.
Mytilus sp.
Macoma sp.
Metis sp.
Ostrea hyotis Linnæus. L.
Pecten leopardus Reeve. L.
Pecten exaratus K. Martin.
Pecten sp.
Placuna placenta Linnæus. L.
Pinna sp.
Spondylus imperialis Chemmitz. L.
Tellina sp. a.
Tellina sp. b.
Conus ornatissimus (variety) K. Martin.
Dolium costatum Menke. L.
Natica sp.
Turbo sp.
Turritella sp.
Leucozia cf. *unidentata* de Haan. L.

The high percentage of Recent species is noteworthy and is in accord with the writer's general conclusions based upon a study of the Vigo fauna.

The corals from the Malumbang formation have not received the careful attention which they deserve, and undoubtedly many important conclusions will be derived from this study. Students of the coral-reef problem may here obtain much material for study, as both Pleistocene and Recent coral reefs occur in this tropical Archipelago as well as in these older beds.

Father Francisco de P. Sanchez, of Ateneo de Manila, recently loaned to the Bureau of Science his collection of fossil corals obtained from the coralline limestones near Mount Mirador Observatory, Baguio, Benguet, Mountain Province. From a

cursory study of this collection it is apparent that several of the species are identical with the reef corals collected from the Malumbang Pliocene at its type locality in the Bondoc Peninsula.

Concerning the coralline limestones of this general region, von Drasche says: [27]

There can be no doubt that the coralline limestones belong to the most recent rocks occurring in northern Luzon. They always form the uppermost member of all formations, and with the exception of Benguet, where they are covered with a thin layer of red earth, I failed to find these limestones beneath other rocks. As has been said, they contain a number of coral fragments which, unfortunately, are in a poor state of preservation; they contain, although only in limited numbers, remains of lamellibranchs, gastropods, echinoderms, etc. All of these fossils have, however, suffered very much on account of the crystallization of the limestone.

A more extensive examination of the same material undertaken by me in conjunction with my honored friend Doctor von Marenzeller, in charge of the collection of the Zoölogical Court Cabinet, led also to substantially the same results.

Even though it was impossible to give a reliable specific report on account of the poor state of preservation of the fossils, it nevertheless was possible for us to declare with certainty that, with the exception of one single piece, which we could not identify, all of the rest belonged to genera which occur to-day in great abundance in the Indian Ocean, and even the individual corals can be referred without any question to living types. The corals examined do not show the least relationship to the Tertiary corals from Java described by Reuss.

Regarded from this point of view, the raised coral reefs of Luzon must be considered as very recent in origin.

The genera identified by us are the following: *Galaxaea* sp., *Favia* sp., *Maeandrina* sp., *Porites* 2 sp., (?) *Astraeopora* sp.

The stratigraphic as well as the paleontologic results go to show that the raised coral reefs of Luzon belong to the most recent geologic formation.

Stratigraphic confirmation of the paleontological correlation of the Mount Mirador limestone with the Malumbang formation was recently obtained by Mr. H. P. Whitmarsh, who collected excellent specimens of *Vicarya callosa* Jenkins, a species characteristic of the Vigo group of Miocene age, from sandstones, lignites, shales, and shaly limestones which dip at an angle of 35° beneath the coralline limestones of Mount Mirador belt. This locality is about 6 kilometers west of Baguio and about 450 meters south of the Naguilian road which runs

[27] Copied from King's translation of Von Drasche's Fragmente zu einer Geologie der Insel Luzon. Wien (1878) 36–46. See Smith's Notes on a geologic reconnaissance of Mountain Province, Luzon, P. I., Philip. Journ. Sci. § A 10 (1915) 185–186.

west from Baguio, elevation, 3,500 feet (about 1,066 meters). An unconformity probably exists near this locality.

As von Drasche pointed out, the great altitude of this coralline limestone is very striking, and the great amount of movement in northern Luzon since these Pliocene coralline limestones were deposited is very notable. Mount Mirador is about 1,200 meters in elevation and similar limestones are reported from Sagada at 1,372 meters. Smith [28] describes the limestone at Sagada as follows:

The most extensive development of it is probably at Sagada, where we find it projecting from the soil and talus in great masses as shown in the photograph. The bedding planes, which can be distinctly made out even in the picture, dip about 20° southeast. On the weathered surfaces the stone is bluish gray, but on fresh fracture it is cream white to reddish. Plate IV, fig. 2, shows the characteristic spirelike forms produced by the dissolving action of the heavy rainfall of this region.

A thin section of the rock shows innumerable fragments of the well-known Mio-Pliocene marine alga, *Lithothamnion ramosissimum* Reuss. This formation, therefore, is equivalent to the upper limestone in Cebu and many other parts of the Archipelago.

Apparently associated with these coralline limestones are some fine-grained tuffs which yielded a fine flora. Smith's description of the locality is as follows:

At Sagada, where Father Staunton, of the Sagada Mission, has opened a quarry to secure material for his new church, is perhaps the best section of the tuff beds to be seen anywhere in the province. The face of the quarry is about 15 meters high and reveals the following beds:

1. Soil and loose material.
2. Tuff in heavy beds, 1.5 to 3 meters.
3. Yellow-stained shale, 0.5 meter.
4. Tuff in solid bed with varying texture, 18 meters.
5. Bluish black shaly-looking rock which is very fine-grained, 1 meter.

* * * The dip is about 20° to the southeast. In the shaly portions are great numbers of leaf impressions.

Doctor Smith submitted these fossils to Mr. E. D. Merrill, botanist of the Bureau of Science, who described them as follows:

The fossil remains, mostly remarkably clear leaf impressions, all, or nearly all, represent species still living in the Philippines at low and medium altitudes, and an examination of the material shows that the forest in the Bontoc locality was a typical mixed dipterocarp forest such as is found to-day in all parts of the Philippines, where primeval vegetation persists, from sea level to an altitude of about 800 meters. None of the species is found to-day within the limits of Bontoc subprovince, and very few of them are to be found in any part of Mountain Province. None of them is found above an altitude of approximately 800 meters, while the present altitude of the fossil-bearing strata is 1,500 meters.

[28] Smith, W. D., Philip. Journ. Sci. § A 10 (1915) 194.

Merrill identified the following living forms:

Dipterocarpaceæ: *Shorea polysperma, Shorea guiso, Shorea* sp., *Anisoptera thurifera.*
Lauraceæ: *Beilschmiedia cairocan, Phoebe sterculioides.*
Guttiferæ: *Calophyllum blancoi.*
Tiliaceæ: *Diplodiscus paniculatus.*
Menispermaceæ: *Anamirta cocculus.*
Cyperaceæ: *Mapania numilis.*

As Merrill points out, great elevations have taken place here since this tropical, low-altitude flora flourished on the present site of Sagada. These tuffs and their associated coralline limestones are probably equivalent to the Malumbang Pliocene. Apparently plants of the tropical regions have changed but little since the Pliocene, thus again evidencing the slowness of evolutionary change in these climes.

BANISILAN FORMATION

UPPER PLIOCENE

The following species were collected from the Banisilan formation by Graham B. Moody at his locality 424 which he described as being 1 mile east of Matinao, $\frac{3}{8}$ mile west of Malitabug River, Cotabato, Mindanao.

List of species from Moody's locality 424.

GASTROPODA

Calliostoma sp.
Cancellaria oblonga Sowerby.
Capulus sp.
Cerithidea sp.
Conus sp., large.
Conus lividus Hwass.
Conus insculptus Kiener.
Cypraea erosa Linnæus.
Cypraea sp.
Distortio clathrata Lamarck.
Dolium sp.
Eulima sp.
Murex cf. *pliciferas* Sowerby.
Nassa crenulata Bruguiere.
Nassa sp.
Natica albumen Lamarck.
Natica mamilla Lamarck.
Natica spadicea Reeve.
Pustularia nucleus Linnæus.
Ranella subgranosa Beck.
Ranella sp.
Sigaretus eximius Reeve.
Triton clavator Lamarck.
Turris flavidula Lamarck var. *sonde* K. Martin.
Terebra sp.

PELECYPODA

Arca cf. *barbata* Linnæus.
Arca cornea Reeve.
Cardita antiquata Linnæus.
Cardita pica Reeve.
Chama sp.
Cardium unicolor Sowerby.
Chione sp.
Corbula sp.
Glycimeris angulatus Lamarck.
Leiconcha trimaculata (Desh.).
Lima sp.
Lucina sp.
Macoma nobilis Hanley.
Ostrea sp. a.
Ostrea sp. b.
Pecten squamosa Gmelin.
Pecten sp.
Spondylus sp.

COELENTERATA, ETC.

Echinoid spine.
Flabellum cf. *australe* Moseley.
Balanophyllia sp.
Cycloseris sp.
Three other coralline forms.
Vermes sp.

All the forms specifically identified are Recent species. The two forms *Flabellum* cf. *australe* Moseley and *Balanophyllia* also occur in Moody's locality 314, Humayan River, between Waloe and Loreto, Agusan Valley, Agusan Province, where they are associated with the following:

Cassis sp.
Cyclonassa elegans Kiener.
Nassa globosa Quoy.
Nassa crenulata Lamarck.
Nassa canaliculata Lamarck.
Cerithium jonkeri K. Martin.
Turritella terebra Lamarck.
Turris carinata Gray.
Arca ferruginea Reeve.
Paphia striata Chemnitz.

The form *Flabellum* cf. *australe* Moseley is identical with the species listed by Warren D. Smith from near Aroroy, on the west side of Aroroy Bay, Masbate, Bureau of Science locality F907, where it has a similar association as indicated above. The *Ballonophyllia* may be an extinct species, and the writer regards the association of these forms with similar assemblages of Gastropoda and Pelecypoda as not merely adventitious but indicative of essential synchrony. In other words, the Banisilan formation is equivalent to the beds exposed at Aroroy and the nearly horizontal beds at Moody's locality 314 in Agusan Valley. The latter are probably equivalent to beds referred to the Pliocene by Martin. Martin [29] listed Mindanao fossils as follows:

1. Left bank of Agusan River at Tagasáp.

Latirus madiunensis Mart. P.
Murex microphyllus Lam. M; L.
Ranella raninoides Mart. M.
Ranella gyrina Linn. L.
Turritella terebra Lam. Q; L.

2. Agusan River between Pagasap and Libuton.

Turritella terebra Lam. Q; L.
Venus squamosa Lam. P; L.

3. Maasin on the Agusan.

Conus insculptus Kien. M; L.
Turricula bataviana Mart. P.
Murex verbeeki Mart. P.
Natica mamilla Lam. M; L.

4. Salac y Maputi River.

Murex verbeeki Mart. P.
Strombus isabella Lam. Q; L.
Natica mamilla Lam. M; L.
Arca granosa Linn. P; L.
Clementia papyracea Gray. M; P; L.
Corbula scaphoides Hinds. M; P; L.

5. Zamboanga, River bank 2.5 miles north of Zamboanga, upper stratum.
Murex capucinus Lam. L.

[29] Martin, K., Concerning Tertiary fossils in the Philippines, English translation, Annual Rep. U. S. Geol. Survey 21 [3] (1899–1900) 619, 622, 623.

Concerning these species, he states his opinion, on pages 622 and 623:

As for Mindanao, it can not be demonstrated from specimens which have been investigated that Miocene strata occur there, for I have but a single species, *Ranella raninoides* Mart., which is known only in the Miocene. On the other hand, it is clear that there are upper Tertiary beds along the Agusan River. If it were permissible to assume that all the fossils of the list given above originated in equivalent beds, and their state of preservation makes this probable, there would be in all 10 species, 6 of them, or 60 per cent, still living; 4 species occur in the Miocene and the same number in the Pliocene; but of these last three are known only from the Pliocene. These are *Latirus madiunensis* Mart., *Turricula bataviana* Mart., and *Murex verbeeki* Mart. All this argues the occurrence of the Pliocene on the Agusan River, and in harmony with this indication is the exceedingly fresh appearance of the fossils at hand.

The same age finally may be ascribed to the fossils from the river Salac y Maputi in Mindanao; for although of the 6 species determined from this locality no fewer than 5 belong to the present fauna, yet of these latter 4 reach back to the Miocene and Pliocene and a single species, *Murex verbeeki* Mart., is known only in the Pliocene. Of the deposit at Zamboanga nothing definite can be said as yet on the strength of the solitary fossil *Murex capucinus* Lam.

To the age determinations of Philippine fossils it is proper to add that their state of preservation resembles that of the Javanese fossils to a very remarkable extent—to such a degree, indeed, that the specimens from the two regions might easily be confounded. The same statement is true of the tuffs and marls in which they were embedded, and this accords with the fact that the younger massive rocks of the Philippines show an extraordinary likeness to those of the East Indian Archipelago.

The writer is in entire agreement with Martin's assignment of the Agusan beds to the Piocene and their analogue, the Banisilan formation, as well. The descriptions of Moody and Smith of the stratigraphic relations of the tuffaceous sandstones at Banisilan yielding the above fauna to the conformably underlying coralline limestone indicate that the Banisilan is upper Pliocene, since the coralline limestone is largely composed of corals characteristic of the Malumbang formation of Pliocene age.

Percentages given in Martin's statement above are calculated on a total of ten species from four different localities, and the number of forms is too small to be truly significant. *Turricula bataviana* Martin occurs at Bureau of Science locality F1054 near San Rafael, Agusan River, where it is associated with a fauna containing at least from 90 to 95 per cent Recent species. Without going into great detail, the writer's judgment concerning the age of this fauna is strongly influenced by a recent study made upon a fauna obtained from the Vigo group of Miocene age which contained an astonishingly large number of Recent

forms. The conclusions given in this paper are that the evolution of Gastropoda and Pelecypoda in the Tropics is far slower than in the Temperate Zones and hence a different percentage scale in the Tertiary must be applied in evaluating the Miocene, Pliocene, and Pleistocene of the Torrid Zone.

PLEISTOCENE

The beautiful Pleistocene limestones exposed in the end of the northwestern peninsula of Leyte offer an exceptional opportunity for the study of the conditions of formation of coralline limestone and allied problems. A cursory examination of these beds seems to indicate that most of the coral species still flourish in the neighboring waters. There are several marine terraces which denote successive uplifts, and each is covered by a thick deposit of coralline limestone. The underlying shales and sandstones of the Vigo group are exposed in a few places in the vicinity, and the unconformity between these beds and the overlying Pleistocene limestone is well marked. The same relation exists between the horizontal Pleistocene deposits and the well-folded Malumbang coralline limestones and interbedded marls at a point about half a mile south of Baliti, a small barrio (village) on the west coast of Leyte. Likewise, along the road on the west side of Cebu from Barili to Alegria, may be seen beautiful exposures which clearly indicate a great time interval between the Pleistocene and the Malumbang Pliocene, thus negativing Becker's [30] tentative idea that—

> Ever since the later Miocene there has been a continuous, very slow, rise of the island [Cebu] and extension of its land area, raising above water successively Upper Miocene, Pliocene, and Pleistocene beds, the total uplift amounting to over 2,000 feet.

Cebu Island has had a much more complicated history.

Nearly all the large islands show distinct terracing in places, but attempts to correlate these terraces from island to island will lead to failure, since there are many evidences of Pleistocene and Recent differential movements. These Pleistocene terraces, as a rule, are mantled by coralline limestone with which is associated a characteristic molluscan fauna such as is illustrated on Plate 15. Practically all of these Pleistocene species have representatives living to-day in these tropic seas.

Much work remains to be done upon the paleontology of the Philippines. Special effort should be made to search the older rocks more thoroughly for Paleozoic and Mesozoic fossils, and

[30] Becker, G. F., Annual Rep. U. S. Geol. Survey 21 (1901) 555.

far larger collections from the Tertiary should be made than are now available. Especial attention should be paid to the study of the Tertiary, Pleistocene, and Recent corals in this inviting field for research. The lack of well-authenticated vertebrate fossils is noteworthy; and any remains of vertebrates, such as those belonging to the horse and elephant families, would be very valuable in fixing in a more definite manner the tentative age correlations now set forth. Careful studies of the distribution of plants and animals such as Mr. E. D. Merrill, director and botanist of the Bureau of Science, and Mr. R. C. McGregor, ornithologist of the same institution, are now carrying on in their respective lines will greatly aid in checking conclusions concerning the geology, paleontology, and paleogeography of the Philippines.

LOCALITIES

Descriptions of localities to which brief reference will be made in explanation of plates are given below:

Locality 1x.—Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, west side of Ragay Gulf; 2.75 kilometers northwest of Bureau of Lands bench mark No. 1, in coarse sandstone (coral and shell sand) dipping 12° south, strike north 50° west. Collectors, E. W. McDaniel and Roy E. Dickerson.

Locality 2x.—Philippine Islands, Luzon, Tayabas; 600 meters upstream from Bureau of Lands bench mark No. 1 (Bahay oil well No. 1) on northeast bank of Bahay River in a 17-meter cliff of yellow sandstone and bluish clayey sandstone disturbed by minor faulting. Collector, Roy E. Dickerson.

Locality 3x.—Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, west shore of Ragay Gulf, Bahay River; upstream 800 meters from Bureau of Lands bench mark No. 1 (Bahay Oil Co. well No. 1) on southwest bank of stream in a stiff dark gray shale. August 25, 1919. Collectors, Roy E. Dickerson and Mark Fuken.

Locality 4x.—Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, west side of Ragay Gulf, Bahay River; 320 meters east of mouth of Apad Creek in road cut 20 meters above the river in yellow sandstone about 17 meters stratigraphically above the brackish water fauna in the lignitic strata of locality 5. Collectors, Roy E. Dickerson and Mark Fuken.

Locality 5x.—Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, west side of Ragay Gulf, Bahay River; 300 meters east of the mouth of Apad Creek in lignitic gray sandstone which was deposited in brackish water. Collector, Roy E. Dickerson.

Locality 6x.—Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, Bahay-Apad Creek; 2.5 kilometers from mouth in large bowlders from Malumbang formation. September 1, 1919. Collector, Roy E. Dickerson.

Locality 7x.—Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, Banco; 33 meters west of house on ridge between Maalat and

Canibo Creeks in a cream-colored yellow clay, a member of the Canguinsa formation. September 4, 1919. Collector, Roy E. Dickerson.

Locality 9x.—Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, Dumalog Creek; about 8 kilometers northwest of San Narciso, 1.2 kilometers downstream from Mulanay-San Narciso trail in uppermost Vigo just below Canguinsa sandstone in black shale. October 17, 1919. Collectors, Roy E. Dickerson and Mark Fuken.

Locality 10x.—Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, Sili Creek; 0.4 kilometer southwest of Sili, in black shale. Vigo shale. October 28, 1919. Collector, Roy E. Dickerson.

Locality 11x.—Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, on west bank of Sapa Tubig Binukot; 365 meters upstream from mouth of Sapa Yaknas. Canguinsa fossils in soft yellow sandstone. October 31, 1919. Collector, Roy E. Dickerson.

Locality 12x.—Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, southern end on Sapa Tubig Binukot (Amuguis River); 274 meters downstream from mouth of Sapa Yaknas in east bank in chalk. Collector, Roy E. Dickerson.

Locality 21x.—Philippine Islands, Leyte Island, west shore of Leyte Bay, Panaliizan Barrio; south 65° east of Panaliizan Hill, west of Tuctuc. Malumbang limestone, at about 200 meters elevation. February 3, 1920. Collector, Roy E. Dickerson.

BUREAU OF SCIENCE LOCALITIES

Locality F7.—Batan, Batan Island, Perseverancia claim, Albay Province. Shale. Collector, W. D. Smith, May, 1905. "Gray shale overlying the East Batan coal seam; contains *Vicarya callosa*, etc., and numerous species of *Corbula*."

Locality F17.—Sitio of Gotas, Sibuguey Peninsula, center, near Sibuguey River, Zamboanga Province, Mindanao. Fossils from coal measures, tunnel 14. Collector, F. A. Dalburg, May 2, 1920.

Locality F272.—Danao, Cebu Province, hill east of mines 233 meters. Upper limestone. Collector, W. D. Smith, February, 1906. "On south slope of Mount Mangilao near Danao. This locality is at the base of the upper limestone and at the summit of a lower limestone horizon. There is a marl below this which is apparently unfossiliferous. The fossils were picked up where they had already weathered out of the formation. Elevation about 200 meters above sea level."

Locality F290.—Philippine Islands, Cebu Province, Naga, Uling coal district. Fossils in Sapa Sibod on Alpaco road (Doña Margarita Roxas). Collector, F. A. Dalburg, his locality 8.

Locality F1054.—San Rafael, Agusan River, Agusan Province, Mindanao Island. Recent sandy shale. Collectors, Ickis and Goodman, 1908.

ILLUSTRATIONS

[The plates of Vigo and Malumbang fossils are from photographs made by Mr. E. Cortes, chief photographer, Bureau of Science, and retouched, by comparison with the specimens, by Mr. Pio Moskaira, chief of drafting section, division of mines, Bureau of Science.]

PLATE 1. MESOZOIC JURASSIC (?) RADIOLARIA

FIG. 1. Thin section of old "slate" of probable Jurassic age, containing Radiolaria; × 100.

2. Highly magnified portion of same thin section; × 200. After W. D. Smith, Philip. Journ. Sci. § A 8 (1913).

PLATE 2. VIGO GROUP, MIOCENE

All fossils figured on this plate were collected from Vigo group, Canguinsa formation, Bondoc Peninsula, Tayabas Province, Luzon.

FIG. 1a. *Architectonica pictum* (Philippi), top view; × 2. Locality 4x. This species is living in Philippine seas at present.

1b. *Architectonica pictum* (Philippi), bottom view of a small specimen; × 8/5. Locality 3x.

2. *Actaeon reticulatus* K. Martin; × 8/5. Locality 3x. An extinct form.

3. *Cancellaria crenifera* Sowerby; × 4/3. Locality 2x. A living species.

4. *Cerithium* sp. nov. (?); × 1. Locality 3x.

5. *Cerithium* sp.; × 2. Locality 4x.

6. *Cerithium bandongensis* K. Martin; × 2. Locality 4x. The type of this species was collected from upper Miocene beds near Bandong, Java. It is probably a good guide fossil for the Vigo group.

7. *Cerithium jenkinsi* K. Martin; × 8/9. Locality 3x. This is an extinct species which is possibly characteristic of the Vigo group.

8. *Cerithium moniliferum* Kiener; × 5/6. Locality 3x. This species is found on the Philippine beaches of the present.

9a. *Cerithium herklotsi* K. Martin; × 1. Locality 3x. This figure illustrates a mature individual whose body whorl is almost smooth in contrast with the upper whorls of the spire.

9b. *Cerithium herklotsi* K. Martin; × 8/5. Locality 3x. In a young individual the nodose body whorl is a youthful character, as our collections contain a striking series which directly connects this development stage with the mature individual.

10. *Cerithidea* cf. *quadrata* Sowerby; × 8/9. Locality 11x.

11. *Conus ornatissimus* K. Martin; × 1. Locality 3x, Bahay River, Bondoc Peninsula, Luzon. This beautiful extinct species is probably a guide fossil of the Vigo Miocene.

12. *Conus lividus* Hwass; × 1. Locality 2x. This beautiful cone is still living in Philippine waters.

13. *Conus striatellus* Jenkins; × 4/5. Locality 9x, Dumalog Creek, Canguinsa formation.
14. *Conus loroisii* Kiener; × 4/5. Locality 5x, Bahay River. This living species was found in a lignitic sandstone bed associated with *Ostrea* sp., *Cerithium* sp., amber, and fossil wood. But a single specimen was found.
15. *Conus hardi* K. Martin; × 8/9. Locality 9x.
16. *Columbella bandongensis* K. Martin; × 1. Locality 3x.
17. *Delphinula reeviana* Hinds; × 2. Locality 4x.
18a. *Delphinula* sp. b, back view; × 2. Locality 4x.
18b. *Delphinula* sp. b, front view; × 2. Locality 4x.
19. *Pyrula* (*Melongena*) *galeodes* Lamarck; × 4/5. Locality 290.
20. *Distortio clathrata* Lamarck; × 8/5. Locality 3x. A living species.
21. *Eburna ambulacrum* Sowerby; × 4/5. Locality 4x.
22. *Epitonium* sp.; × 1. Locality 11x.
23. *Ficus reticulatus* (Lamarck); × 8/9. Locality 11x. This is a beautiful species, which is living in the China Sea.

PLATE 3. VIGO GROUP, MIOCENE

FIG. 1. *Fusus verbeeki* K. Martin; × 7/6. Bureau of Science locality F290, Uling district, Cebu, Sibod Gulch, Alpaco road; collector, F. A. Dalburg.
2. *Harpa articularis* Lamarck; × 4/5. Locality 11x.
3a. *Mitra javana* K. Martin; × 1. Locality 3x. The outer lip of this specimen is somewhat broken, thus exposing the lirations on the inner lip unusually well. This form is probably restricted to the Vigo group.
3b. *Mitra javana* K. Martin; × 8/5. Locality 2x. A young individual.
3c. *Mitra javana* K. Martin; × 4/5. Locality 4x. An unusually slender form of this species.
4. *Mitra junghuhni* (?) K. Martin; × 8/5. Locality 3x.
5. *Mitra bucciniformis* K. Martin; × 2. Locality 4x.
6. *Mitra* sp.; × 2. Bureau of Science locality F290.
7. *Mangelia balteata* Reeve; × 2. Locality 4x.
8. *Murex endivia* Lamarck; × 1. Locality 3x.
9. *Murex* sp.; × 9/8. Locality 2x.
10. *Murex* (?) sp.; × 7/8. Bureau of Science locality F290.
11a. *Marginella simplicissima* K. Martin; × 8/9. Back view. Locality 4x.
11b. *Marginella simplicissima* K. Martin; × 8/9. Locality 4x.
12. *Nassa dispar* Adams; × 1. Locality 3x. All the members of this genus thus far identified from the Philippine Miocene are living forms. *Nassa canaliculata*, *N. dispar*, and *N. crenulata* are three closely allied species whose variations are difficult to classify.
13. *Nassa canaliculata* Lamarck; × 1. Locality 3x.
14a. *Nassa crenulata* Bruguiere; × 1. Locality 3x.
14b. *Nassa crenulata* Bruguiere; × 2. Locality 4x.
15a. *Nassa globosa minor* Quoy; × 8/5. Front view. Locality 3x.
15b. *Nassa globosa minor* Quoy; × 8/5. Locality 3x. *Nassa globosa minor*, *N. globosa leptospira*, *N. globosa thersites*, and *N. quadrasi* form a closely allied group.

16. *Nassa quadrasi* Hidalgo; × 8/5. Locality 3x.
17a. *Nassa thersites leptospira* (Bruguiere); × 8/5. Locality 3x.
17b. *Nassa thersites leptospira* (Bruguiere); × 5/4. Front view. Locality 3x.
18a. *Nassa thersites immersa* Carpenter; × 8/5. Back view. Locality 3x.
18b. *Nassa thersites immersa* Carpenter; × 5/6. Front view. Locality 3x.
19. *Nassa costellifera* A. Adams; × 8/9. Locality 11x.

PLATE 4. VIGO GROUP, MIOCENE

FIG. 1. *Natica albumen* Lamarck; × 7/5. Locality 2x.
2. *Natica* sp.; × 4/3. Locality 9x.
3a. *Natica spadicea* Reeve; × 9/8. Locality 2x.
3b. *Natica spadicea* Reeve; × 4/5. Locality 11x.
3c. *Natica spadicea* Reeve, operculum; × 8/9. Locality 11x.
4. *Natica lacernula* D'Orbigny; × 8/5. Locality 3x.
5. *Natica mamilla* Lamarck; × 5/6. Locality 2x.
6. *Natica cumingiana* Recluz. Locality 11x.
7. *Nerita funiculata* Reeve; × 5/6. Locality 2x.
8. *Neritina* cf. *squarrosa* Recluz; × 8/9. Locality 5x.
9. *Oliva* cf. *utriculus* Gmelin; × 8/5. Locality 3x.
10. *Phos roseatus* Hinds; × 8/5. Locality 3x.
11. *Pyrula gigas* K. Martin; × 4/5. Locality 5x.
12. *Pyramidella* sp. Locality 4x.
13a. *Ranella subgranosa* Beck; × 7/6. Bureau of Science locality F290. Sibod Creek, Uling district, Cebu. The lower tip of the canal is broken off, giving the form a more robust appearance than the Recent specimens in the Quadras collection.
13b. *Ranella subgranosa* Beck; × 8/5. Locality 2x.
14. *Ranella tuberculata* Broderip; × 7/5. Locality 2x.
15. *Ricinula spectrum* Reeve; × 2. Locality 4x.
16. *Rimella agusana* (Smith); × 4/5. Locality 10x, Vigo shale, Sili Creek, at seepage, southern end of Bondoc Peninsula, Tayabas Province, Luzon. This species was originally described as a *Turris*, but better material necessitates its reference to another genus.

PLATE 5. VIGO GROUP, MIOCENE

FIG. 1a. *Rostellaria fusus* Linnæus; × 4/6. Locality 4x.
1b. *Rostellaria fusus* Linnæus; × 4/6. Locality 4x. The upper whorls of the spire are decorated in contrast to the smooth whorls below.
2. *Rostellaria crispata* Kiener; × 1. Locality 3x.
3. *Strombus canarium* (Linnæus); × 7/6. Bureau of Science locality F290.
4. *Strombus gendinganensis* K. Martin; × 1. Locality 3x.
5. *Strombus* sp. a; × 4/5. Locality 4x.
6. *Strombus swainsoni* Reeve; × 5/6. Locality 2x.
7. *Strombus dentatus sonde* (Lamarck) K. Martin; × 1. Locality 3x.
8. *Strombus* cf. *fusus* K. Martin; × 4/6. Locality 9x.
9. *Turris flavidula* Lamarck; × 7/5. Locality 2x.

10. *Turris garnonsi* Reeve; × 1. Locality 3x.
11. *Turris deshayesi* (Doumet); × 4/3. Locality 2x.
12a. *Turris carinata woodwardi* K. Martin; × 1. Locality 3x.
12b. *Turris carinata woodwardi* K. Martin; × 5/6. Locality 2x. This is a mature form whose body whorl is more robust than that of the immature individual shown as fig. 12a.
13. *Turris marmora* (Lamarck); × 4/5. Locality 4x.
14. *Terebra bicincta* K. Martin; × 4/3. Locality 2x. This species is probably characteristic of the Vigo group.
15. *Terebra javana* K. Martin; × 4/3. Locality 2x. This is an extinct Vigo form.
16. *Triton pfeifferianum* Reeve; × 1. Locality 2x.
17. *Turbo* (?) sp.; × 2. Locality 4x.
18. *Tubonilla* sp.; × 4/3. Locality 2x.

PLATE 6. VIGO GROUP, MIOCENE

FIG. 1a. *Vicarya callosa* Jenkins; × 3/4. Bureau of Science locality F17. Tunnel No. 14, Sibuguey Peninsula, Mindanao; collector, F. A. Dalburg. This "finger post" of the Malayan Miocene is found at numerous localities in the Philippines, and as a rule the strata containing specimens are associated with the coal seams or lignitic strata.

1b. *Vicarya callosa* Jenkins; × 4/3. Bureau of Science locality 7. Gray shale overlying the East Batan coal seam in the Perseverancia claim, Batan Island; collector, F. A. Dalburg. This picture illustrates the size and peculiar character of the callosity as developed upon a mature specimen.

1c. *Vicarya callosa* Jenkins; × 4/3. Bureau of Science locality 7. Showing spire whorls of a mature specimen.

2. *Voluta innexa* Reeve; × 3/4. Bureau of Science locality 272, Cebu.
3. *Arca ferruginea* Reeve; × 8/9. Locality 4x.
4. *Arca granosa* Linnæus; × 9/8. Locality 3x.
5. *Arca tenebrica* Reeve; × 2. Locality 5x.
6. *Arca* sp.; × 2. Locality 2x.
7. *Cardium elongatum* Bruguiere; × 8/9. Locality 11x.

8a. *Cardium unicolor* Sowerby; × 8/9. Locality 11x.
8b. *Cardium unicolor* Sowerby; × 8/9. Locality 11x.
9a. *Cardium donaciformis* Cuming; × 4/3. Locality 2x.
9b. *Cardium donaciformis* Cuming; × 4/3. Locality 2x.
10. *Cardita antiquata* Linnæus; × 8/9. Locality 11x.
11. *Corbula socialis* K. Martin; × 5/6. Locality 3x.
12a. *Corbula* sp.; × 4/3. Locality 3x.
12b. *Corbula* sp.; × 4/3. Locality 3x.
13a. *Corbula scaphoides* Hinds; × 5/6. Locality 3x. View of right valve of small specimen.
13b. *Corbula scaphoides* Hinds; × 4/3. Locality 3x. View of left valve, which is much smaller than right.
14. *Dosinia cretacea* Philippi; × 4/5. Locality 9x. Dumalog Creek, Bondoc Peninsula, Tayabas Province, Luzon.
15a. *Glycimeris viteus* (Lamarck); × 8/9. Locality 11x. View showing hinge.
15b. *Glycimeris viteus* (Lamarck); × 8/9. Locality 11x.

16a. *Lucina* cf. *argentia* Reeve; × 2. Locality 11x. This form is semi-transparent and the ribbing corresponds to Reeve's species, but the shape is somewhat different.
16b. *Lucina* cf. *argentia* Reeve; × 2. Locality 11x.
17. *Ostrea* sp.; × 5/6. Locality 5x.

PLATE 7. VIGO GROUP, MIOCENE

FIG. 1. *Pecten* (*Pleuronectia*) *pleuronectia* Linnæus; × 5/6. Locality 4x.
2a. *Placuna placenta* Linnæus; × 2/3. Locality 4x.
2b. *Placuna placenta* Linnæus; × 2/3. Locality 4x.
3. *Paphia textrix* Deshayes; × 3/4. Locality 2x.
4. *Spisula* sp.; × 2. Locality 11x.
5. *Vermetus javanus* (?) K. Martin; × 4/5. Locality 11x.

PLATE 8. FORAMINIFERA FROM CEBU

FIG. 1. *Alveolinella;* × 10. Old Alpaco mines, Cebu; locality F273.
2. *Orbitolites;* × 10. Locality F273.
3. *Operculina costata* d'Orbigny; × 10. Minanga River, Cebu, F277.
4. *Operculina costata* var. *tuberculata* Douvillé; × 10. Old Alpaco mines, Cebu, F273.
5. *Cycloclypeus communis* Martin; × 10. Minanga River, Cebu, F277.
6. *Heterostegina;* × 10. Barrio of Mesaba, Cebu, F272.
7. *Lepidocyclina insulæ-natalis* Jones and Chapman; × 10. Guila-Guila, Cebu, F278. After a slide prepared by Warren D. Smith.

PLATE 9. VIGO GROUP, MIOCENE

Lepidocyclina limestone from Cebu (copied from Yabe). The fossils figured were collected at Puting Bato, Cebu, near Cebu City, from limestone.

FIG. 1b. *Lepidocyclina* (*Eulepidina*) *formosa* Schlumberger.
1c. *Lepidocyclina* (*Eulepidina*) *gibbosa* Yabe.
1g. *Spiroclypeus* cf. *margaritatus* Schlumberger, in oblique section.
1h. *Cycloclypeus* or *Heterostegina*, in transverse section; × 7.
2b. *Lepidocyclina* (*Eulepidina*) *formosa* Schlumberger.
2h. *Cycloclypeus* or *Heterostegina*, both in transverse section; × 15.

PLATE 10. VIGO GROUP, MIOCENE

Lepidocyclina limestone from Cebu (copied from Yabe).

FIG. 1b. *Lepidocyclina* (*Eulepidina*) *formosa* Schlumberger.
1g. *Spiroclypeus* cf. *margaritatus* Schlumberger; × 7. In oblique section.
2. *Lepidocyclina* (*Eulepidina*) *monstrosa* Yabe; × 7. In tangential section.
3a. *Lepidocyclina* (*Eulepidina*) *monstrosa* Yabe. In tangential section.
3b. *Lepidocyclina* (*Eulepidina*) *formosa* Schlumberger; × 7. One in transverse section through the nucleoconch, and the other in almost median section.

PLATE 11. MALUMBANG FORMATION, PLIOCENE

All the specimens figured on this plate, except *Chione chlorotica*, were collected from locality 1x, Malumbang formation, Bondoc Peninsula, Tayabas Province, Luzon.

FIG. 1a. *Leucosia* cf. *unidentata* de Haan; $\times \frac{4}{3}$. Ventral view.

1b. *Leucosia* cf. *unidentata* de Haan; $\times \frac{4}{3}$. Dorsal view.

2. *Conus ornatissimus* K. Martin; $\times \frac{9}{11}$. This is a form at least subspecifically different from the typical *C. ornatissimus* of Martin. The notable difference is the greater width of this Pliocene form.

3. *Cardita antiquata* Linnæus; $\times 1$. This form is very abundant in the Recent fauna of the Philippines.

4a. *Aspergillum annulosum* Deshayes; $\times \frac{4}{3}$. This very aberrant pelecypod has all the characters common to the Recent species which was originally described from the Vizcayan seas.

4b. *Aspergillum annulosum* Deshayes; $\times \frac{9}{11}$.

5. *Chione chlorotica* Philippi; $\times \frac{3}{4}$. Bureau of Science locality 1054, Agusan Valley, from Pliocene strata, probably equivalent to the Banisilan Pliocene.

6a. *Glycimeris multistriatus* (Deshayes); $\times \frac{4}{3}$. In view showing hinge characters. This species is still flourishing in Philippine waters.

6b. *Glycimeris multistriatus* (Deshayes); $\times \frac{4}{3}$.

7. *Lucina* cf. *borealis* (Linnæus); $\times \frac{2}{3}$. This species was collected from the Malumbang strata of Leyte, locality 21x. Reeve reports *L. borealis* from Manila Bay, but Hidalgo states that this species is not reported by any other Philippine collector.

8. *Metis* (?) sp.; $\times \frac{3}{4}$.

9. *Ostrea* sp.

10a. *Pecten leopardus* Reeve; $\times \frac{3}{4}$. Right valve.

10b. *Pecten leopardus* Reeve.

11a. *Pecten exaratus* K. Martin. Left valve.

11b. *Pecten exaratus* K. Martin. Right valve.

PLATE 12. MALUMBANG FORMATION, PLIOCENE

FIG. 1a. *Pecten naganumana* Yokoyama; $\times \frac{2}{3}$. This, the type of this species, was described by Dr. M. Yokoyama, of the Imperial University of Tokyo, from the Lower Musashino formation of probable upper Pliocene age.

1b. *Pecten naganumana* Yokoyama; $\times \frac{2}{3}$. Convex right valve.

2. *Spondylus* sp.

3. *Spondylus imperialis* Chemnitz; $\times \frac{5}{6}$.

4. *Venus squamosa* Lamarck; $\times \frac{5}{6}$. Bureau of Science locality 1054.

5. *Fungia* sp.; $\times \frac{7}{6}$. Bureau of Science locality.

6a. *Flabellum* cf. *australe* Moseley; $\times \frac{9}{11}$.

6b. *Flabellum* cf. *australe* Moseley; $\times \frac{9}{11}$.

7. *Leptoria* sp.; $\times \frac{5}{4}$. Locality 6x.

PLATE 13. MALUMBANG FORMATION, PLIOCENE

FIG. 1. *Goniastraea* sp.; $\times \frac{3}{7}$. Locality 6x.

2. *Acropora* (?) sp.; $\times \frac{2}{3}$. Locality 6x.

3a. *Clypeaster* sp. a; $\times \frac{4}{3}$. Locality 1x. Abactinal view.

3b. *Clypeaster* sp. a; $\times \frac{4}{3}$. Actinal view of specimen figured as 3a.

4. *Clypeaster* sp. b; $\times \frac{5}{6}$. Bureau of Science locality.

5a. *Schizaster subrhomboidalis* Herklots; $\times \frac{2}{3}$. Bureau of Science locality. Aboral view.

5b. *Schizaster subrhomboidalis* Herklots; $\times \frac{2}{3}$. Oral view of specimen figured as 5a.

PLATE 14. MALUMBANG FORMATION, PLIOCENE

Fossil plants from Sagada, Mountain Province, Luzon. The figured specimens were identified by Mr. Elmer D. Merrill, of the Bureau of Science.

FIG. 1. *Beilschmiedia cairocan* Vidal. An endemic species of the Lauraceæ.

2. *Phoebe sterculioides* Merrill. An endemic species of the Lauraceæ.

3. *Anamirta cocculus* Wight and Arnott. An Indo-Malayan species of the Menispermaceæ.

4. *Shorea polysperma* Merrill. An endemic species of the Dipterocarpaceæ.

PLATE 15. PLEISTOCENE

Fossils from raised coral reefs near San Andres, Bondoc Peninsula, Tayabas Province. About one-half natural size (after Pratt and Smith).

FIG. 1. *Conus flavidus* Lamarck.

2. *Strombus* sp.

3. *Strombus* sp.

4. *Potamides* sp.

5. *Spondylus* sp.

6. *Telescopium telescopium* Linnæus.

8. *Trochus fenestratus* Gmelin.

9. *Crista pectinata* Linnæus.

10. *Cerithium nodulosum* Bruguiere.

11. *Circe pectinata* Linnæus.

12. *Potamides* sp. Youthful individual of the form shown in fig. 4.

13. *Arca cornea* Reeve.

14. *Strombus canarium* Linnæus.

PLATE 16

Map of the Philippine Islands.

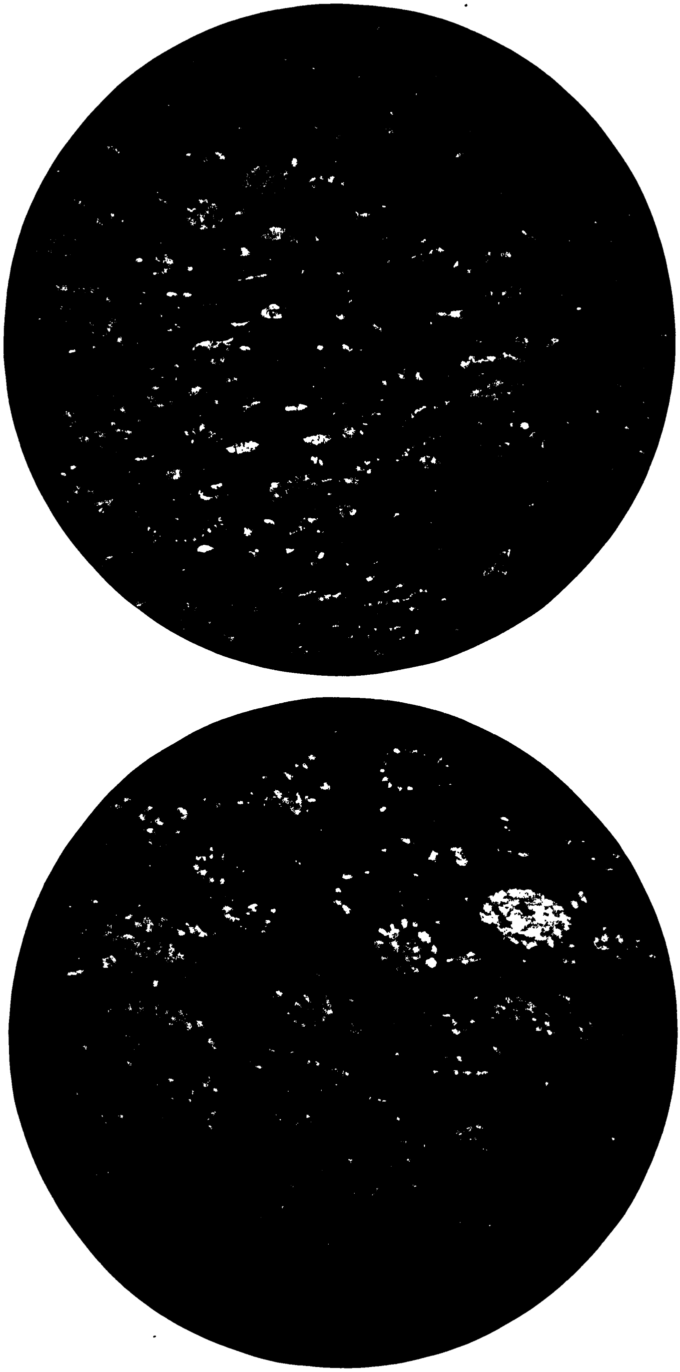


PLATE 1. MESOZOIC, JURASSIC (?) RADIOLARIA.

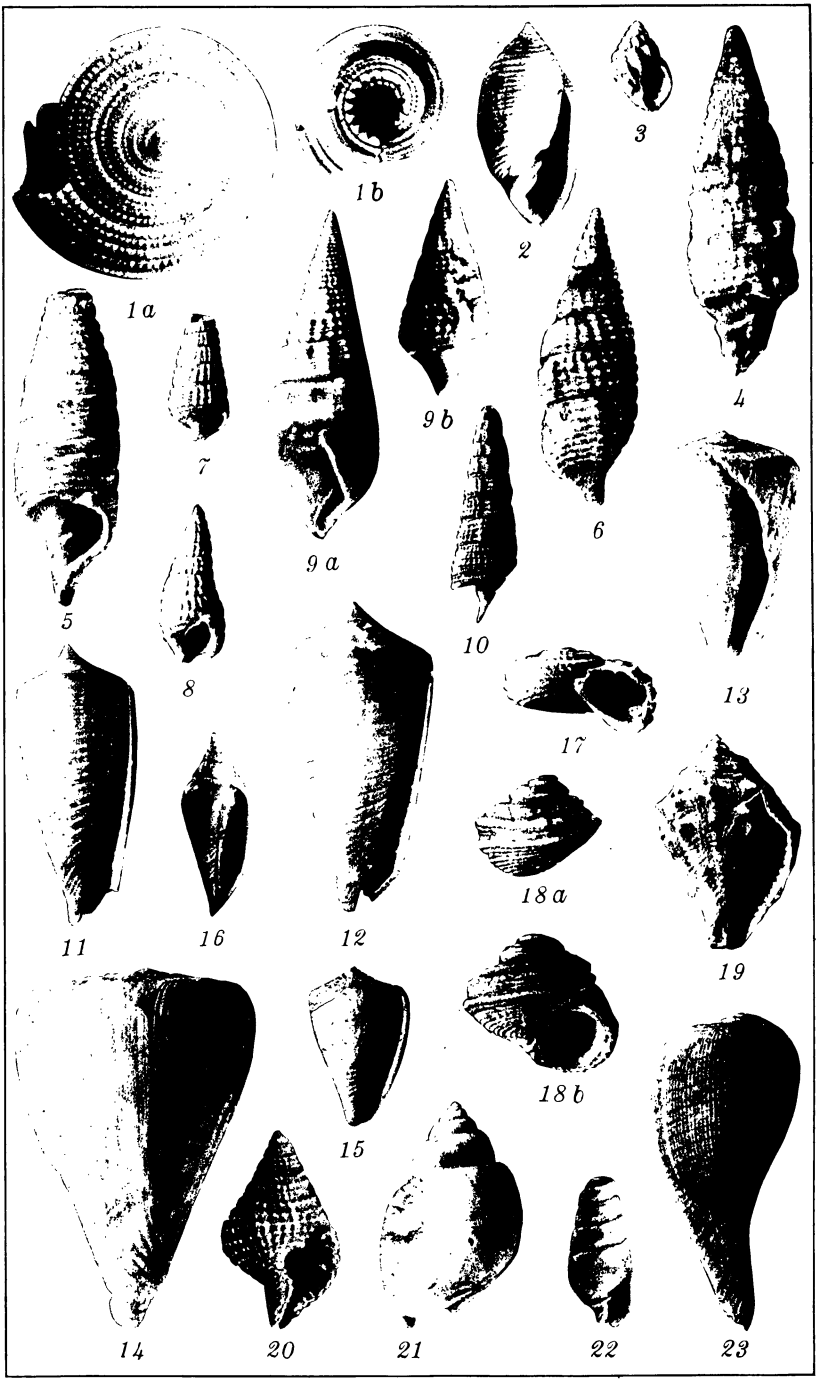


PLATE 2. VIGO GROUP, MIOCENE FOSSILS.

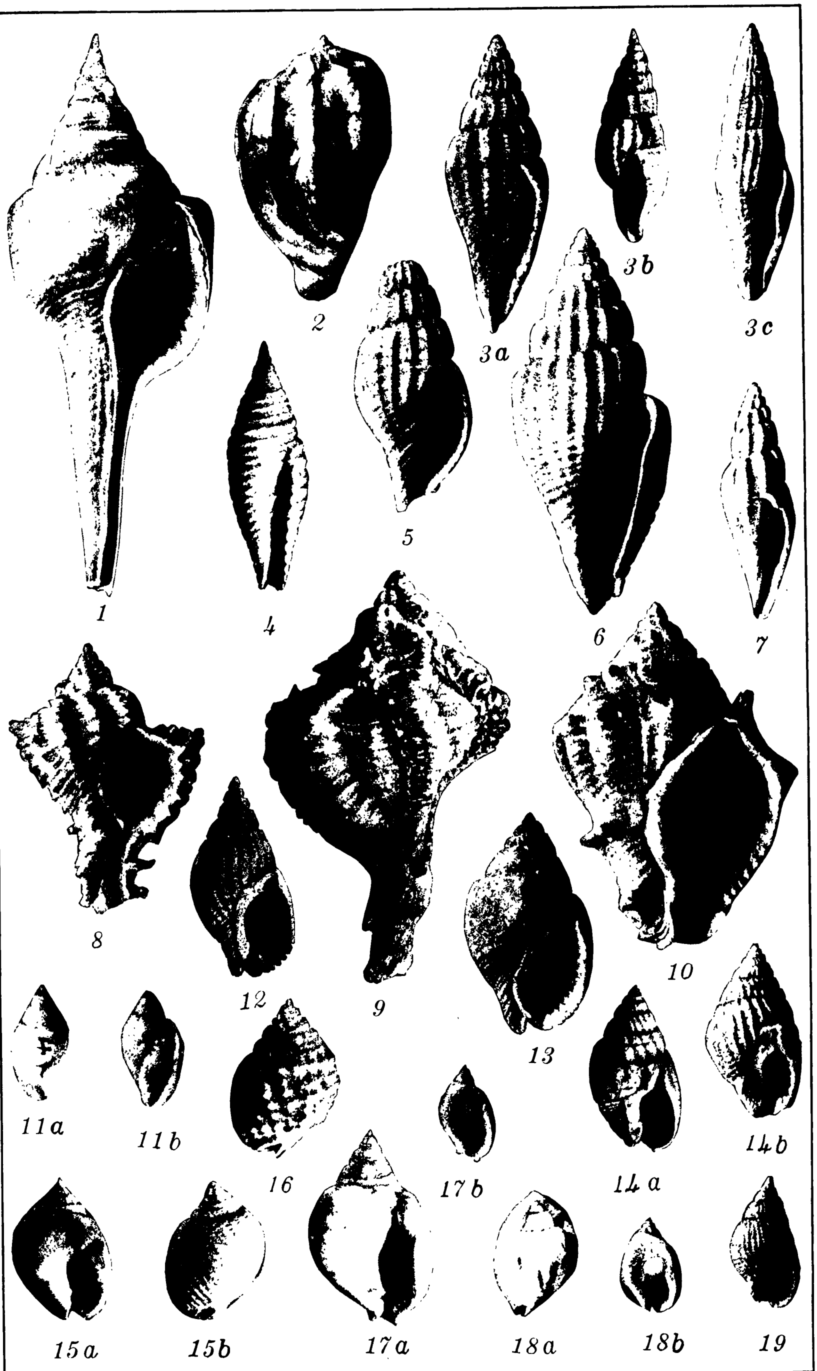


PLATE 3. VIGO GROUP, MIOCENE FOSSILS.

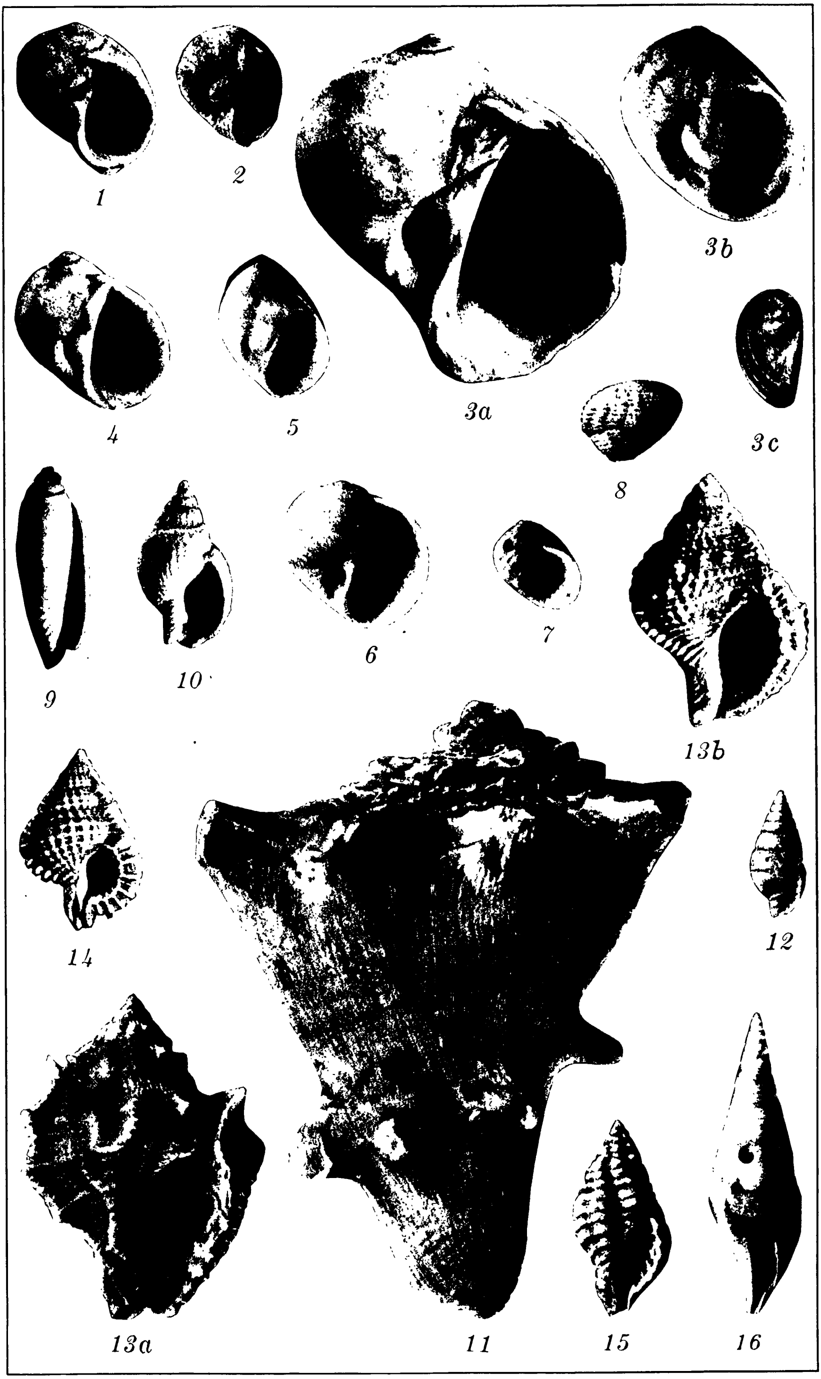


PLATE 4. VIGO GROUP, MIOCENE FOSSILS.

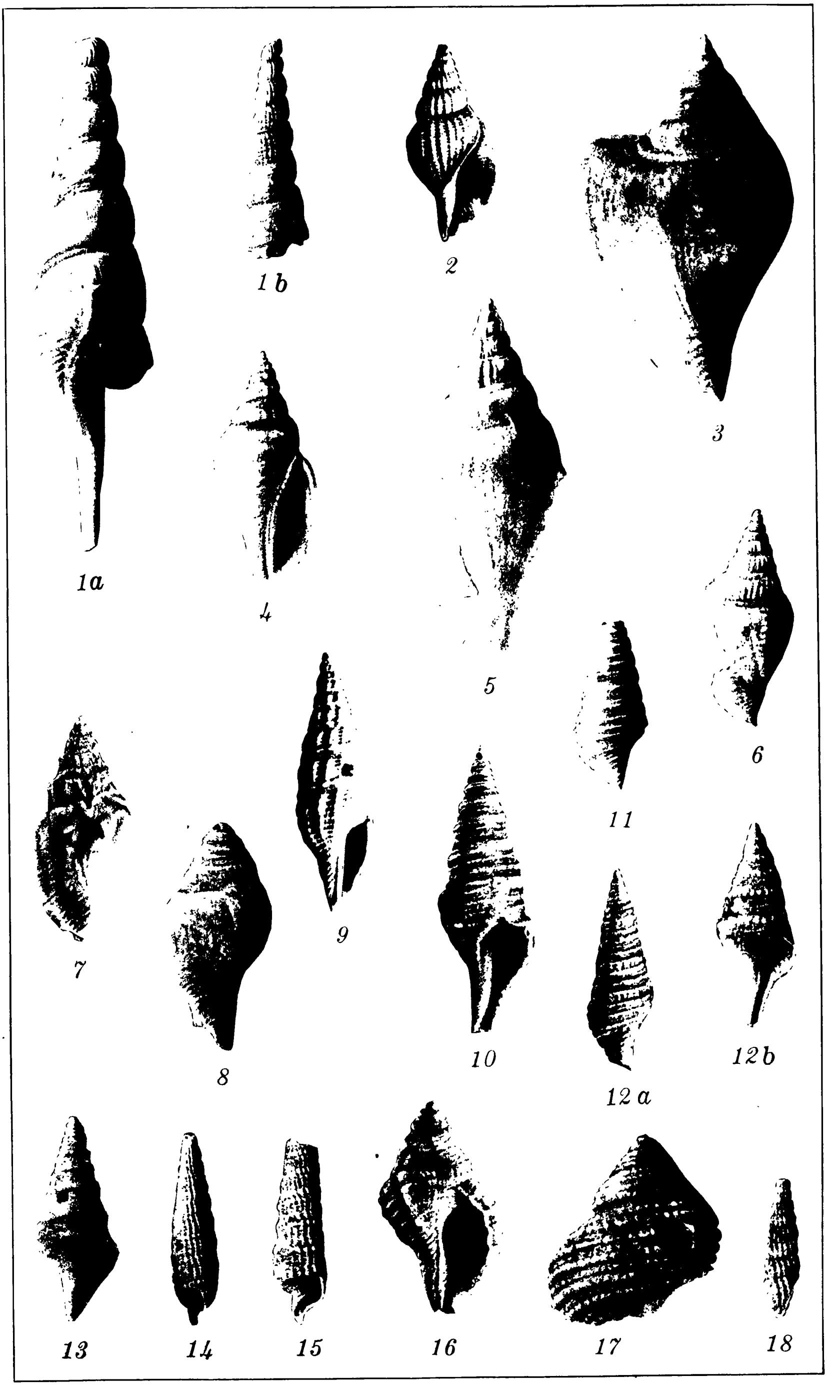


PLATE 5. VIGO GROUP, MIOCENE FOSSILS.

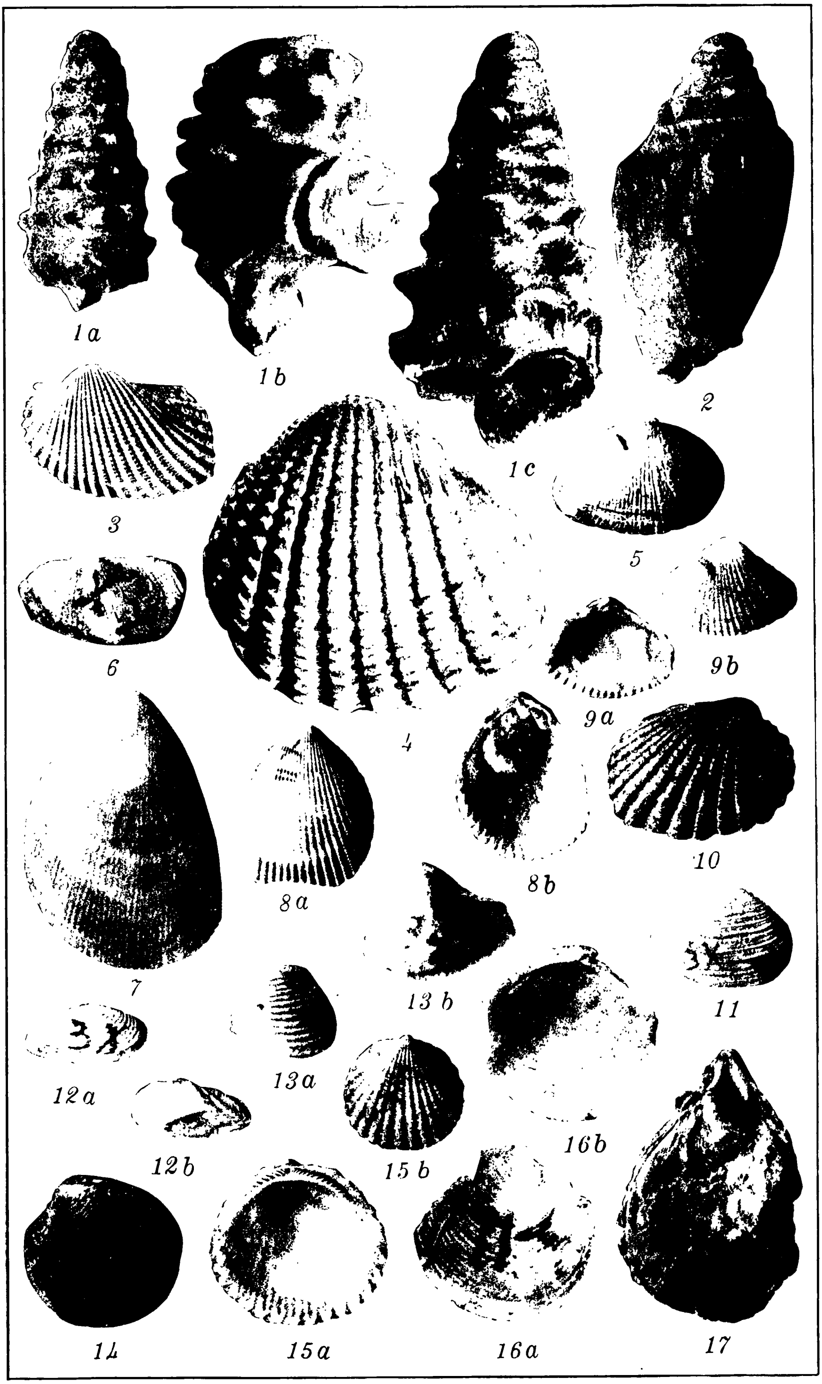


PLATE 6. VIGO GROUP, MIOCENE FOSSILS.

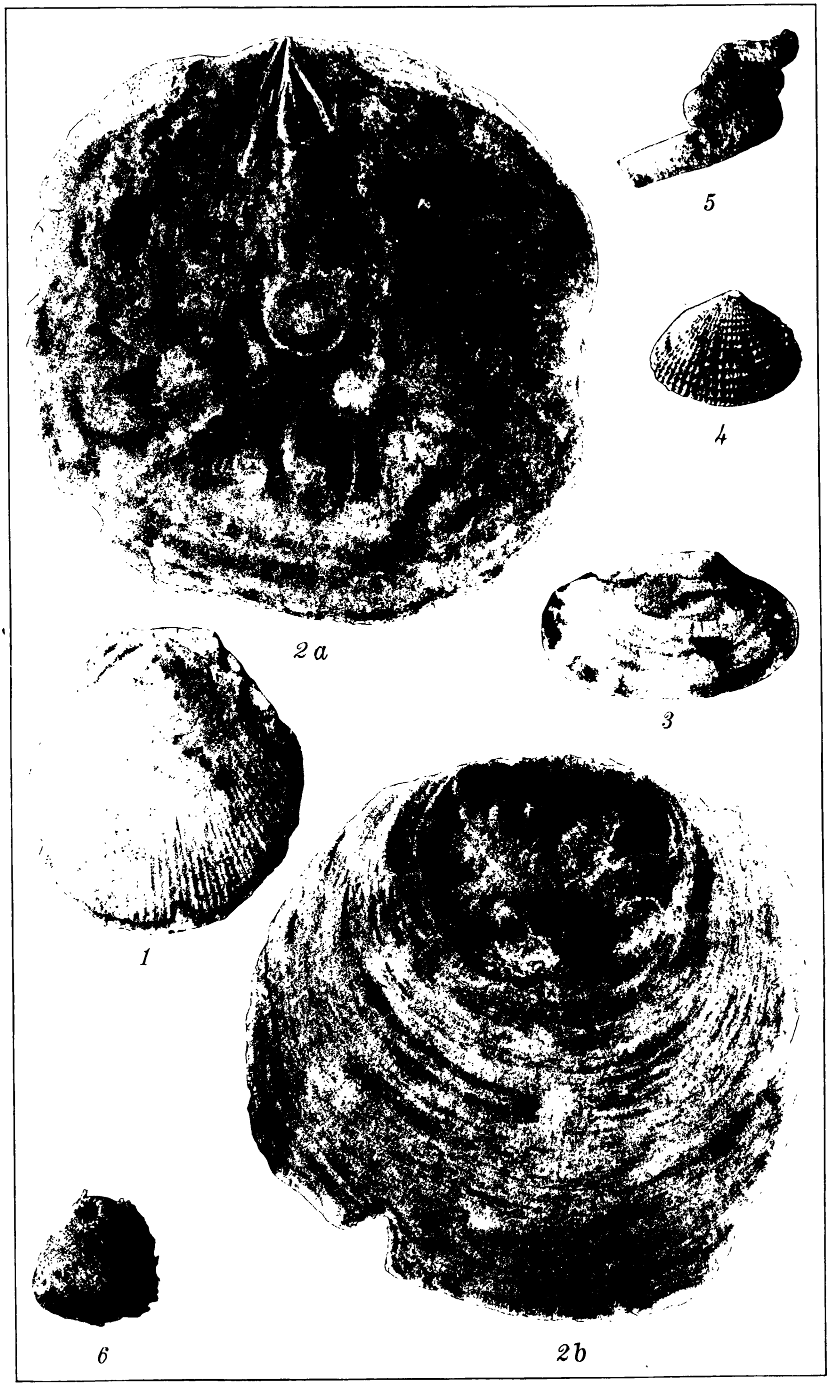
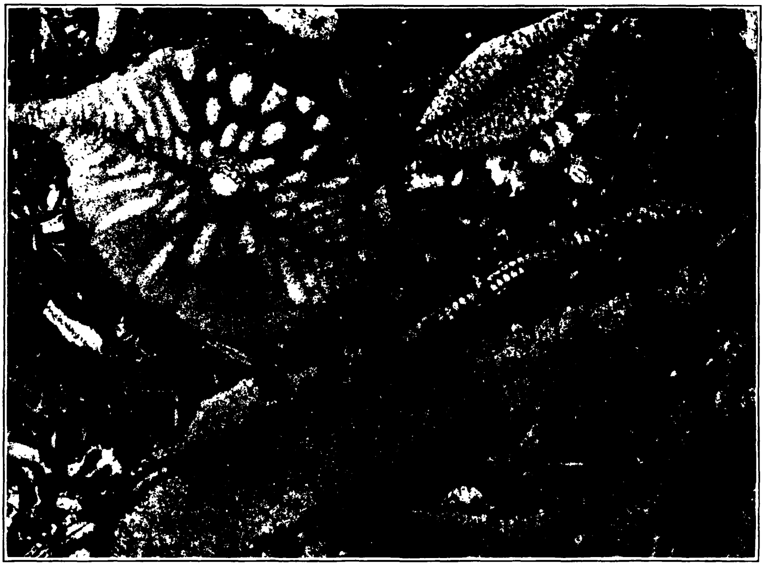


PLATE 7 VIGO GROUP, MIOCENE FOSSILS.

PLATE 8. FORAMINIFERA FROM CEBU.



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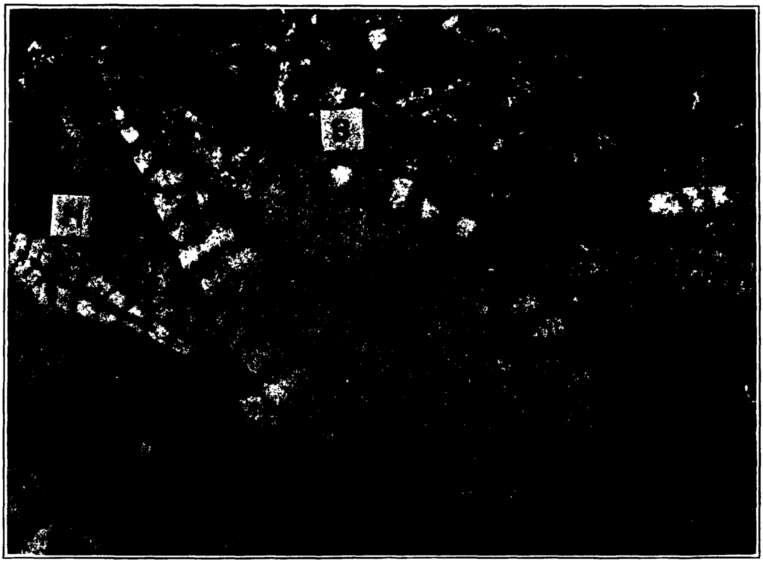

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PLATE 9. VIGO GROUP, MIOCENE FOSSILS.

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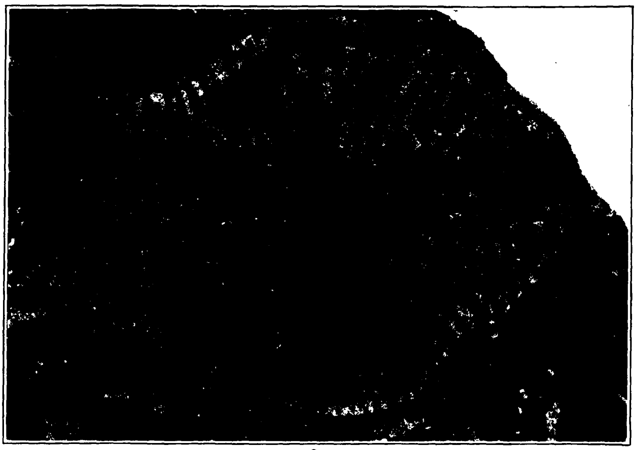

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PLATE 10. VIGO GROUP, MIOCENE FOSSILS.

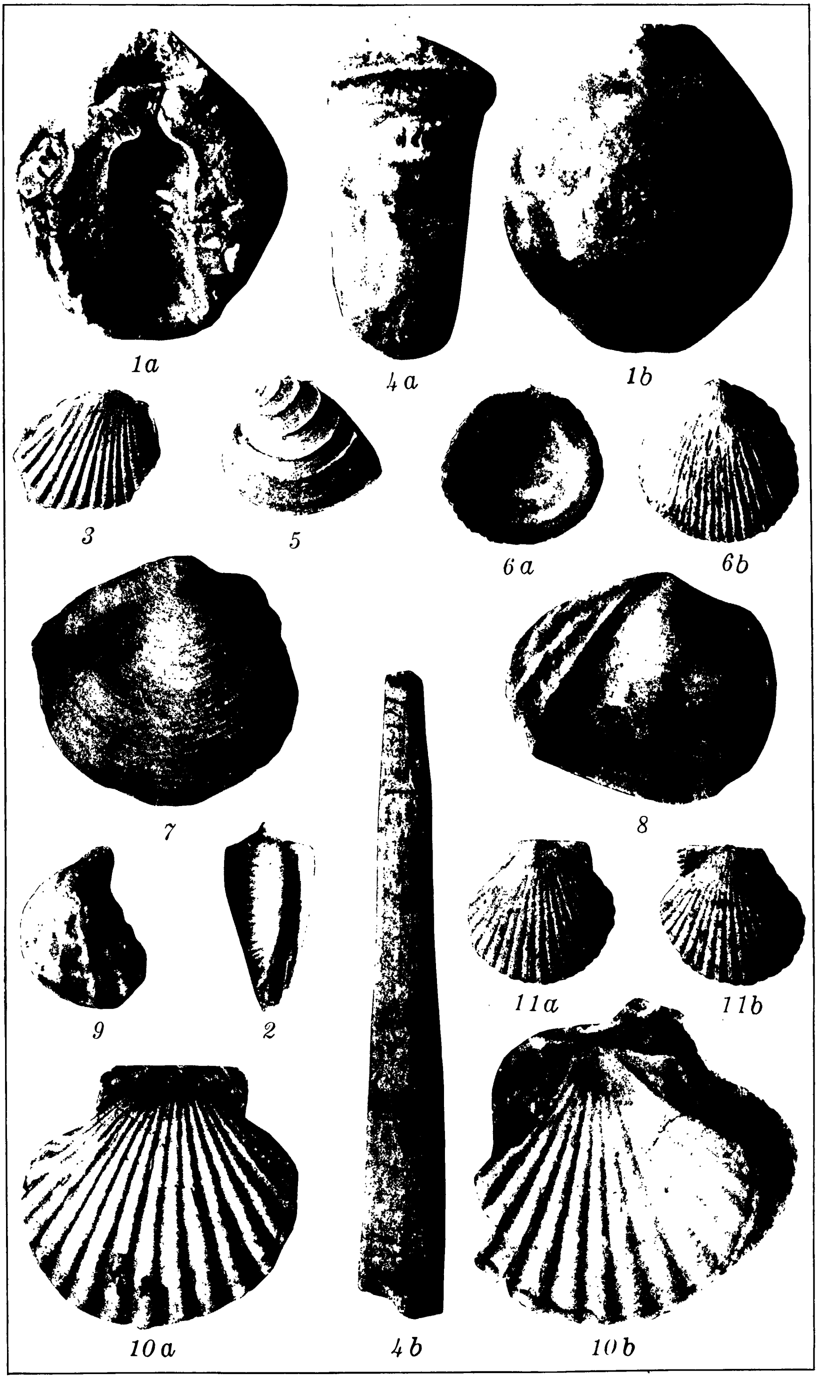

PLATE 11. MALUMBANG FORMATION, PLIOCENE FOSSILS.

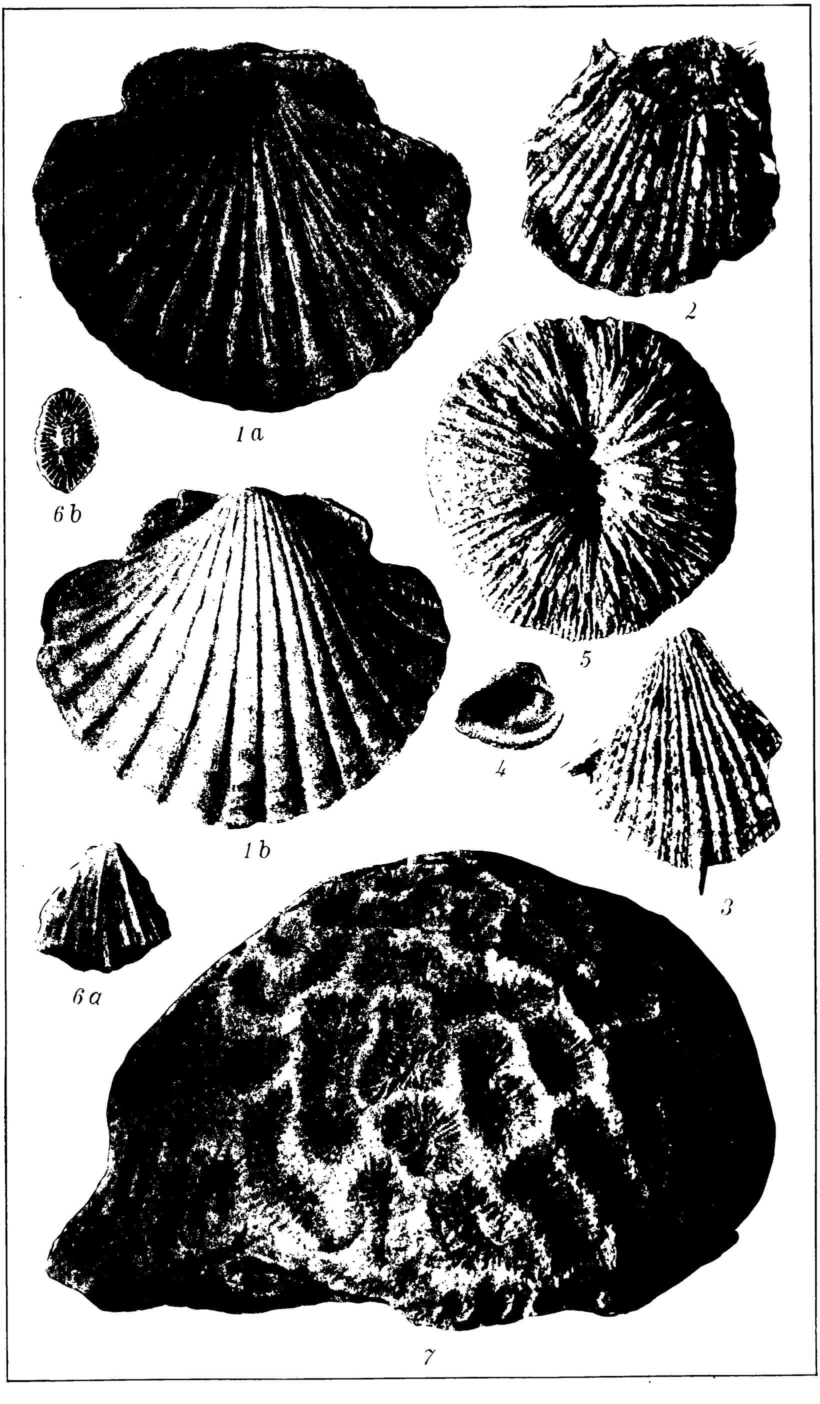

PLATE 12. MALUMBANG FORMATION, PLIOCENE FOSSILS.

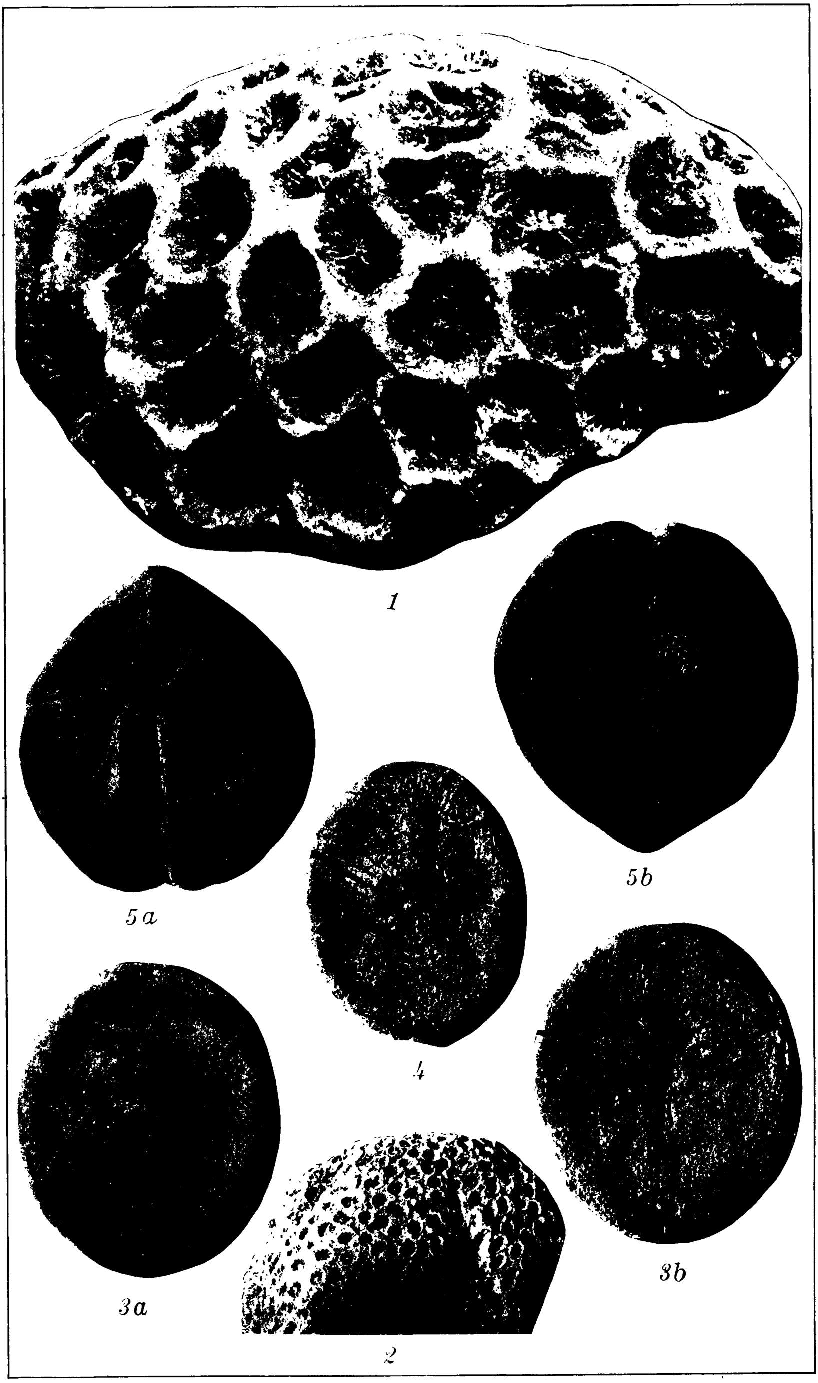

PLATE 13. MALUMBANG FORMATION, PLIOCENE FOSSILS.

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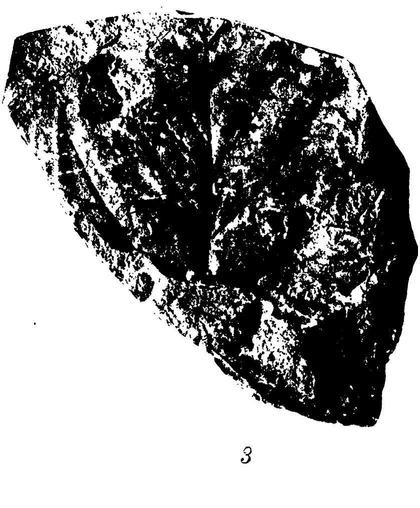

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PLATE 14. MALUMBANG FORMATION, PLIOCENE FOSSILS.

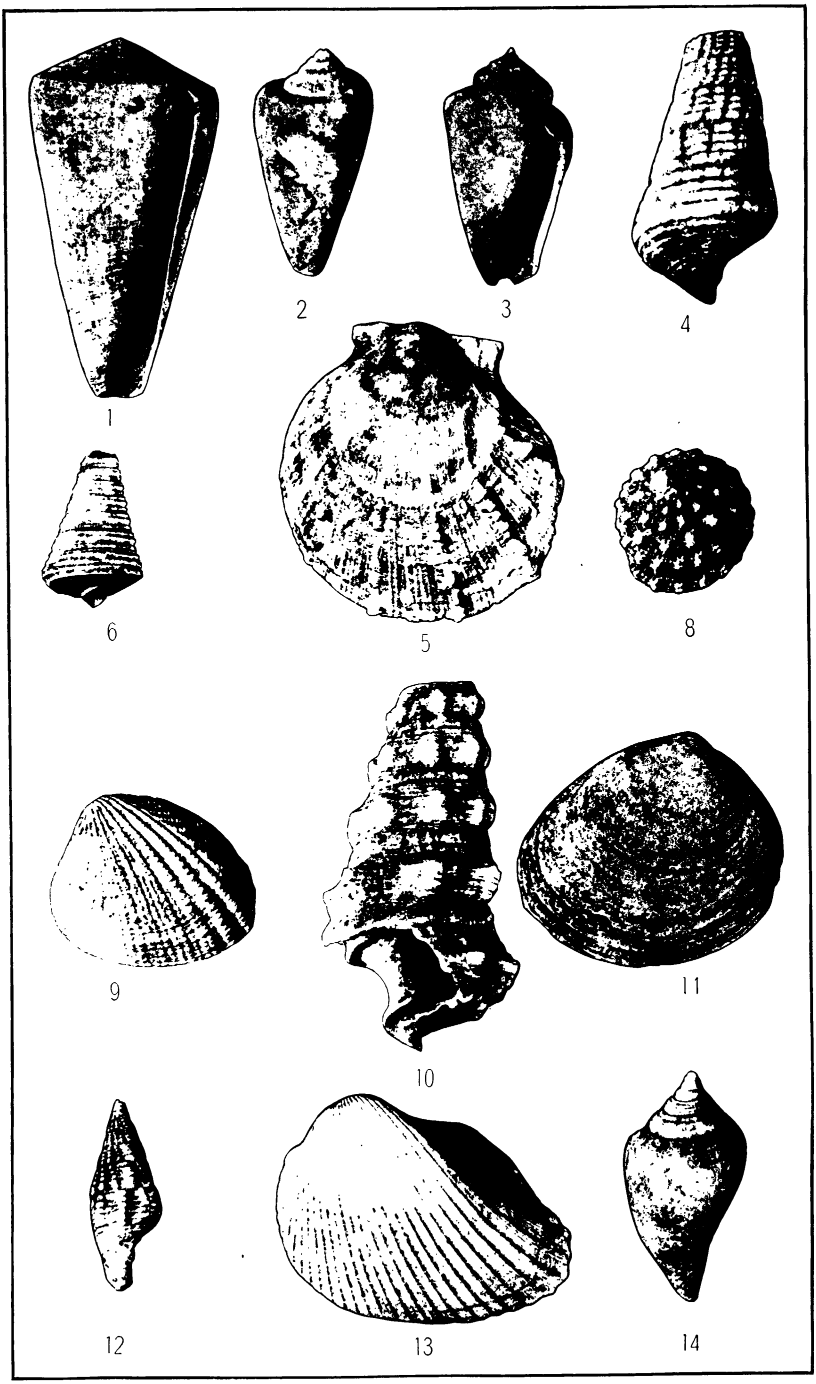

PLATE 15. PLEISTOCENE FOSSILS FROM BONDOC PENINSULA.

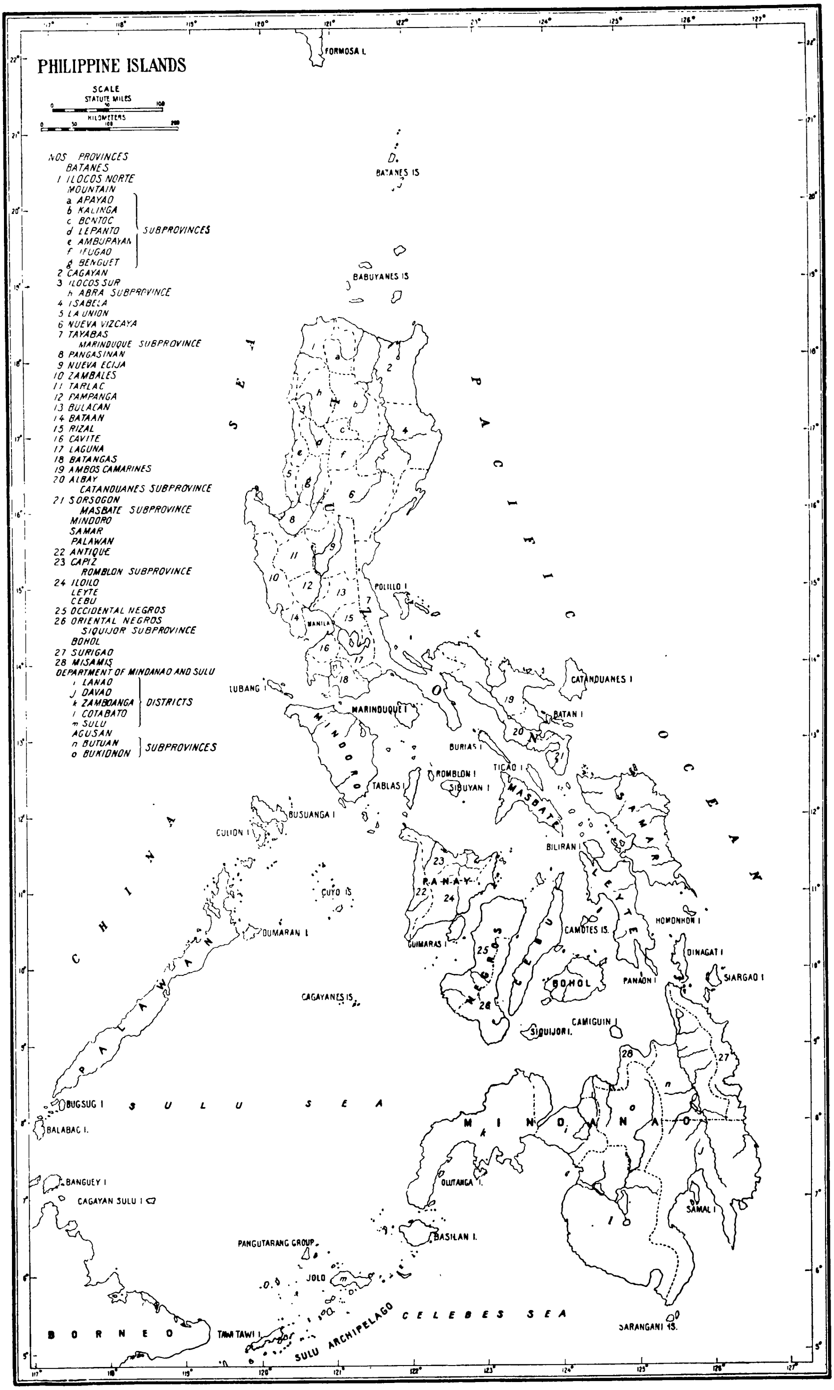

PLATE 16. THE PHILIPPINE ISLANDS.

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THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 20 MARCH, 1922 No. 3

PHYSIOGRAPHY AND GEOLOGY OF SAMAR ISLAND, PHILIPPINE ISLANDS

By HUBERT G. SCHENCK

Of the Division of Mines, Bureau of Science, Manila

FIVE PLATES AND THREE TEXT FIGURES

CONTENTS

INTRODUCTION

It was in 1521 that the navigator Magellan sighted a "rough, mountainous island called by the natives Zamal" and his findings were recorded. From time to time, since his day Samar has been lifted out of its obscurity by historical events or because of the occurrence of an earthquake or a typhoon of more than ordinary severity. For the most part, however, scientists seem to have passed the island by, rich though the field may prove

to be. There are scattered brief accounts of the natural history of the island. Jagor, a German scientist, spent some time on Samar, and his two chapters relating to the island represent the nearest approach to anything accurate that has been produced. No geologic survey was ever made of this country until our party made its general reconnaissance during November and December, 1920. The purpose of this paper is to present the results of that exploration.

SUMMARY

These observations and conclusions are offered as contributions to science rather than as direct aids to the economic geologist, since it was found that Samar is far from being a rich mineralogic province. Gradation, aided by diastrophism, has so well dismembered the strata that there now exists no definite cordillera; instead, there are short mountain ranges, many streams, and no great elevations and, consequently, no sharp differentiation between the wet and the dry seasons. Physiography has strongly influenced the economic development of the island and has had a marked effect on the social development of its inhabitants. The rocks are principally sedimentary ones deposited in the shallow waters bordering an island which, in its early history, had an igneous core. As time went on, many changes of level took place until in fairly recent times comparatively flat beds of marl, shale, and sandstone were deposited and the present land forms carved out. It is unlikely that Samar will become a center of mineral production, for industrially important minerals are apparently entirely lacking or of inferior quality.

GENERAL STATEMENTS

LOCATION

Samar Island is that member of the Visayan group of islands of the Philippine Archipelago which is immediately southeast of Luzon Island, and north and east of Leyte Island. It lies between 11° 01′ and 12° 36′ north latitude, and 124° 15′ and 125° 46′ east longitude. Between Samar and Luzon is San Bernardino Strait, while the narrow, tortuous San Juanico Strait separates Leyte from Samar. Catbalogan, the capital, is, on a direct line, 525 kilometers southeast of Manila.

SHAPE AND AREA

Samar may be considered as a large trapezium, the longer sides running northwest and southeast and the shorter sides bearing approximately east and west. Considering this geo-

metric form, we find that the southern side, Basey to Guiwan, measures roughly 80 kilometers; the northern coast from Balicuatro Point to Cape Espiritu Santo, 100 kilometers; the east coast from Cape Espiritu Santo to Guiwan, 185 kilometers. The fourth, the west-coast side, extends from Balicuatro Point to Basey, a distance of 170 kilometers. Its entire area is about 12,000 square kilometers.

COAST

There is no open port of entry in Samar,[1] and most of the business is carried on through Manila. Interisland boats usually touch only at Catbalogan and Calbayog, both open roadsteads. On the east coast there is no good port for vessels of any size, and on the entire island only one port ranks as high as class 2.

ROADS

According to the Director of Public Works, the roads in Samar Province, as of June 30, 1920, are as follows:

	Km.
First-class roads	103.4
Second-class roads	44.7
Third-class roads	91.2
Total	239.3

Road construction on the island is difficult, owing to the type of topography, the climate, the geology, the lack of funds, and other factors. The only roads available for use by automobiles are short stretches along the north, east, and west coasts. There is no complete cross-island road, although one is projected from Wright to Taft, through a natural pass.

MAPS

One of the two most accurate maps of Samar Island, Bureau of Public Works map bearing the date 1920, was prepared under the direction of the district engineer of Samar, Mr. Ralph Frush. This map gives the correct location, as far as known, of towns, streams, and other features. The Coast and Geodetic Survey map of 1920 (No. 13) is excellent and is the only one that gives a good suggestion of the topography. Many maps of the island are so inaccurate as to lead one to the conclusion that it is dotted with towns and villages, which is certainly far from being the case.

[1] Coast and Geodetic Survey charts Nos. 4715, 4719. Hydrograhpic Office charts Nos. 2049, 1729, 1730. See Bull. C. and G. S. Sec. IV, P. I. Sailing Regulations.

CULTIVATED AREAS

The Philippine Census of 1918 gives the area of farms in Samar Province as 177,357 hectares; that is to say, approximately 13 per cent of the total area of the island is under cultivation. The cultivated tracts of land lie principally along the coasts. There are rich farms in the valleys of Catubig, Gandara, Catarman, Dolores, Ulot, Calbiga, and Basey Rivers; but little of the land in the interior is devoted to agriculture. Some of the rich uncultivated districts on the island could be developed to produce more rice, copra, and abacá, the principal agricultural products at present grown. Agricultural development apparently is hindered by poor means of communication and insufficient population. The population, by the enumeration of 1918, was stated as being 362,399.

CLIMATE

The wet and the dry seasons on Samar are not so sharply defined as they are on some of the other islands of the Archipelago. Those planning to go into this country are strongly advised not to attempt field trips during November, December, and January especially, for the heaviest rains occur then. Typhoons usually are most violent during September and October. The climate, however, throughout the year is cool and healthful and, on the whole, more pleasant than that of Manila.

FIELD WORK

The chief of our party was Graham B. Moody, who was engaged in economic work. I was detailed by the Bureau of Science to coöperate with him. Distance, or time, traverses were made wherever possible, directions being obtained by a Brunton compass, and elevations by an aneroid barometer. The time spent in the field extended from October 30 to December 7, 1920, during which period the following itinerary (see Plate 4) was followed:

Catbalogan to Calbayog, thence up Gandara River to Matuguinao, and returning to Catbalogan. From there, we proceeded to Wright and Loquilocan, Concord (Bagakay), and Taft.

From Taft the route followed was to Maslog, on Dolores River; by trail to Concepcion, Jipapad, and San Vicente, and from the latter place by boat down Catubig River to the town of Catubig and on to Laoang, thence along the north coast to Catarman and Carangian, where the party boarded a launch for Basey.

The final stage of the trip was from Basey to Calbiga, thence to Wright, and finally back to Catbalogan.

ACKNOWLEDGMENTS

I am particularly indebted to Mr. Moody for assistance rendered by him in the field, for his aid in the interpretation of the data obtained, for his criticism of the manuscript, and for other important details.

Dr. Warren D. Smith assisted me in the determination of the rocks and verified the classification that appears herein. He made many valuable suggestions, and I am deeply indebted to him for this aid.

Dr. Roy E. Dickerson, of the Richmond Petroleum Company, has carefully criticised the paper, made fossil determinations, and otherwise assisted me in the preparation of the paper. I desire to express my sincere gratitude for this.

Fr. M. Saderra Masó, S. J., of the Weather Bureau in Manila, outlined some of the climatic conditions to me and supplied me with the note on recent earthquakes which forms a portion of this account.

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The list of acknowledgments would be incomplete if I made no mention of the various Americans on Samar Island, particularly Messrs. Frush, Shawger, and Ryans, who rendered valuable assistance to the party during its reconnaissance. Their coöperation and interest made the work easier and more agreeable than it otherwise might have been.

PHYSIOGRAPHY

The name Samar perhaps is derived from the Visayan word *samad,* meaning "wounded," or "cut up." Although it cannot be said that the original namers of the island had physiographic peculiarities in mind, nevertheless, this definition well describes the island's topography. Physiography has been, and still is, an important factor in the development of the province, and it is partly for this reason that more than passing attention is given the subject.

RELIEF AND DRAINAGE

As one approaches Samar from the west, he notices that the skyline of the island is more or less regular, though slightly serrate, suggesting peneplanation or perhaps widespread terracing. Numerous small islands lie off the coast. A closer view

of the island near Catbalogan shows the topography to be mature, and a more extended survey proves that the island, as a whole, is maturely dissected, although the area in the northwest corner is more youthful. Relatively speaking, the relief of the island is low, for there is no peak higher than 1,000 meters, and there are no prominent ones such as are to be seen on Leyte.

The arrangement of the rivers and their branches in Samar is more or less dendritic, as the accompanying map (Plate 5) will show. The island is drained by streams that meander to a very great degree. Some of these streams appear to be in the second cycle of erosion, typically in the region between Buau and Matuguinao. Rivers are more abundant and longer on the east than on the west coast; and in places those of the Pacific side appear to be drowned (near Taft), while on the west coast there are evidences of uplift.[2] The swamps at the mouths of the rivers are due, therefore, to uplift and a ponding of the water, and are not the result of subsidence and overflow alone. The headwaters of the streams are rocky and in many cases dangerous. Ulot River is probably an antecedent stream that rises remarkably near the west coast, and upon nearing the ocean appears to be controlled by an uplifted marine terrace (see fig. 3).

NATURE OF THE TOPOGRAPHY

Since the topography of Samar is mature, the area of undissected surface is not great. The valleys that now exist are due, for the greater part, to erosion of nearly flat beds of soft material. This cutting action has been aided by uplift and local folding and faulting. In most cases the valleys are not wide, but they are numerous; it is probable that some of them are structural. For example, near the barrio of Jipapad on the Jipapad-San Vicente trail there are two small valleys which appear to be fault valleys. The soils of the valleys are usually clayey, though in places they contain some sand.

Marine terracing is inferred from certain features, as will be pointed out, and future work probably will show that these features have markedly affected the topography of the country. From present information, it may be stated that the high peaks of Samar have a general northwest and southeast trend; that is to say, they follow the general direction of the island.

[2] Recent uplift at Basey was reported by Jagor in his "Journeys" and was noted at Wright, Calbiga, and other localities by our party.

Attention should be called to the rough topography in the limestone districts, such as at Matuguinao, where there are great caverns, sinks, and subterranean streams. The caving of these sinks results in the formation of coves and, later, valleys. Mention has been made elsewhere of islands that have been formed from blocks of limestone cut off from the parent mass.

When one considers the causes for the nature of the topography, one sees that the stage of maturity has resulted from variation in the hardness of the rocks, differential crustal movements, and erosion due to excessive rainfall.

OUTCROPS AND TOPOGRAPHY

Along the west coast of Samar, principally south of Calbayog, the shale hills with their inland dip and steep seaward escarpment furnish abundant outcrops, and at low tide harder beds are exposed. The topography here is that of shale hills resulting from minor folding, minor and major faulting, and tropical erosion.

Good outcrops in the beds of creeks can be seen on the north coast, where durable sandstones and a well-cemented conglomerate, especially near the Catarman Agricultural School, give a prominent, but not high, coastal ridge. The northwest corner of the island is composed in part of hills of basalt now in erosional youth.

On the south coast the best exposures are along the seashore. They consist of massive limestone masses, which are being undercut by wave action. Near the sitio of Hilabá, municipality of Basey, a series of hat-shaped islands has resulted from this undercutting. Near the town of Basey, opposite Tacloban, Leyte, is a prominent shale and sandstone hill, overlain by what may be a river conglomerate.

On the eastern side of the island the low hills lying inland from the coastal plain are chiefly composed of soft sandstone, marl, and a lignitic clay, which have been exposed by the cutting action of the streams. On the left (north) bank of Malinao (Tubig) River, opposite the barrio of Taft, is a faceted spur of massive, bluish marl. There is a narrow coastal plain in this region, and coral reefs occur offshore.

The outcrops in the interior of Samar seen by our party were found chiefly in creek beds, and they consisted of flat, sandy shale (marl), clay, limestone, some andesite and basalt, and on Ulot River east of Loquilocan a hard plagioclase porphyry. As

has been stated, the valleys vary from youthful in the igneous areas to mature in areas of less-resistant rocks.

Vegetation, with its subduing effect, conceals the rocks more or less, and the shape of the outcrops cannot be determined. It seems definite, however, that the larger masses of limestone are in the interior and southern sections of Samar; that most of the igneous formations are in the center of the island and at the northwestern corner; that shales and marls, more or less flat, are common; and that the general strike of the peaks is slightly west of north.

PHYSIOGRAPHY AND CLIMATE

The rainfall is somewhat heavier on the east coast of Samar than elsewhere on the island, the annual fall there being more than 3,500 millimeters. This precipitation is exceeded only by the rainfall in the Benguet district, and at Iba, Zambales. The mean annual rainfall for the entire province is slightly more than 3,200 millimeters, with about 1,900 millimeters between November and February. Therefore, of all the provinces and subprovinces in the Archipelago, Samar ranks third in the amount of rainfall.[3]

Since there is no marked dry season on this island, erosion is taking place all the time and is checked only by the vegetation. The result on the topography of Samar as a whole is such that it is difficult to say whether or not a central cordillera exists. It is my opinion that there is no marked "backbone." Instead, erosion (and one must not forget wave action) due to great amounts of rain, together with structural features, has cut the mountains, which formerly were more continuous, into ridges and hills. There is no great difference between the amount of rainfall on the east and west coasts. This is in marked contrast to the other large islands of the Archipelago, especially those that have a definite cordillera, and this fact, alone, seems to indicate the nonexistence of a central mountain system that would act as a barrier to rain-laden winds. The only area of more-marked difference in the amount of rainfall is a small district around Calbayog, where the annual average is less than 2,500 millimeters, while Catbalogan, about 38 kilometers southeast, has a much greater average. This is perhaps explained by the fact that the igneous area and the higher peaks near Calbayog protect the city from the northeast monsoons. It can

[3] Coronas, Rev. José, S. J., The climate and weather of the Philippines, 1903 to 1918, Census of the Philippine Islands 1 (1918) 342–403.

be seen, therefore, that even to-day climate is playing an important part in the erosion of Samar.

Another physiographic feature due to this excessive precipitation is the coastal plain on the east coast. It has been noted that the rainfall there is slightly in excess of that on the west coast; consequently, more sediment is carried down by the rivers, thereby making the plains wider. The excess of rainfall on the east side of the island is due to the fact that the water-laden winds from the Pacific meet Samar as first land, so that these winds lose most of their moisture there; but, unlike Luzon, the northeasterly winds carry much rain to the west coast.

The temperature of Samar, as recorded at stations situated near the sea, has an annual normal of about 26.5° C. or about 0.4° C. below the mean annual temperature of the entire Archipelago.[4] The relation between temperature and ocean currents and rains is far closer than that between temperature and physiography. The same probably holds true with respect to cloudiness and relative humidity. I noticed little difference between the temperature in the interior and that along the coast, although places at elevations of more than 200 meters were reached. The diurnal variation was most noticeable at Matuguinao.

Physiography, rainfall, and typhoons are interrelated. A large proportion of the typhoons of moderate to destructive severity that cross the Philippines pass over Samar, and my observations there incline me strongly to the belief that typhoons aid erosion to no small degree.

A review of the relations between physiography and climate indicates that on Samar, at least, topography is the resultant of climate, and that climate does not entirely depend upon topography, although the two are closely related. Corrosion and corrasion of this island proceed at a maximum rate because of the wide distribution of heavy rainfall.

PHYSIOGRAPHY AND VEGETATION

Persons journeying across Samar Island are seldom able to see the country lying before them—a vista shows only another wooded hill ahead. As a matter of fact, this seems to hold true for the entire island except, perhaps, in the shale hills, where the vegetation is either secondary or less dense, or where deforestation has taken place. The trees are smaller on the

[4] Coronas, Rev. José, S. J., op. cit. 296–341.

northern and eastern coasts [5] where the winds are strong. The northwest corner is perhaps the most heavily forested area. There are found the large toog, mayapis, lauan, apitong, and other species, although the shale hills also support some of these large trees. As in other islands, the limestone districts are heavily forested. Merrill [6] reports various plants from Catubig River; but, although some of the plants come from as far inland as the towns of Tagabiran and Las Navas, none of the specimens occur at elevations of more than 300 meters. Nipa and mangrove swamps are abundant, the largest being at the mouth of Gandara River. Vegetation is luxuriant on Samar and has effectively concealed much of the geology of the island.

PHYSIOGRAPHIC INFLUENCES

It has been said often that Samar is one of the most undesirable islands in the Archipelago, as regards its inhabitants and the character of the country. Of interest and value, therefore, might be a brief account of how topography has actually affected the development of the people. The principal effects, I believe, have been upon land communications, transportation by water, agriculture, and the temperament of the people.

First.—The population centers chiefly along the coasts where communication is easier, although even this is not too simple, since there are many rivers to cross. In the interior of the island there are few trails, few large rich valleys, no rich upland plateaus, and consequently few towns, except along the rivers. In the limestone areas, conditions exist similar to those in the cove districts of eastern Tennessee, United States; the country is rugged, sinks are numerous, trails are almost entirely lacking, and the people are little inclined to travel. Indeed, of the whole island one might say that the trails are chiefly the meandering creeks with a cut-off now and then over a ridge, and that the people who do travel from the interior or cross the island do so only because of dire necessity, for the maturity of the topography makes land communication a difficult matter.

Second.—None of the rivers of Samar are navigable except for shallow-draught boats. Launches drawing little water can go up some of the larger rivers, but the entry into the streams is always hindered by the ever-present bars at their mouths.

[5] Forest reconnaissance of Samar, Annual Rep. P. I. Bur. Forestry, app. A (1916) 59–70.

[6] Merrill, Elmer D., New plants from Samar, Philip. Journ. Sci. § C 11 (1916) 175–206.

The ports are little better than anchorages for ocean-going vessels, and are in no way protected from typhoons. The sea-coast towns, as would be expected, have attracted more tradesmen and more people than have the isolated interior villages off the rivers. Furthermore, the people in the interior are kept at home by dangerous headwaters of rivers. The narrow San Juanico Strait, along a seismotectonic line, provides a means of water transportation between southwestern Samar and north-eastern Leyte; but the windy, rough, and treacherous San Bernardino Strait well isolates Samar from Luzon. Both land and water communications, therefore, are by no means favorable to the economic development of the island.

Third.—The agricultural lands, naturally, are the river valleys and narrow coastal plains. The interior can boast of little tillage, but one cannot blame physiography alone for that. There is entire lack of a large plain approaching that of the Luzon plain, so that it devolves upon the numerous smaller valleys to produce whatever is raised. Much of the land is very fertile and simply awaits development, which to-day is fostered by the schools; but the fact that there are extensive agricultural units has brought about almost a tribal relationship among the inhabitants, who cultivate in one place what little is needed for their own sustenance, and go to the forest for resin, honey, and wax. They do not grow any larger crops than seem necessary to meet their own needs.

Fourth.—The people of Samar, chiefly Visayans, are to some degree held down because of their environment. The natives are not fond of travel, and one can scarcely blame them! Cargadores usually will go from one barrio to another only. Though in the majority of cases poor, the people are usually hospitable, and certainly are more amiable than we have been led to believe by some visitors among them. They know little of their own island and even less about the remainder of the Archipelago, but that is not particularly characteristic of them. The Pulajan religious fanatacism of the early days of the American occupation was certainly not hindered by the nature of the terrane. Better communications will open a potentially rich agricultural province and will aid in the education and unification of the people.

To summarize: The physiography of Samar is, in many ways, unlike that of Luzon and Leyte. Nearly all of this province is maturely dissected; an igneous area is limited in extent, while limestone is abundant. Rivers, shallow and rocky, are extremely

numerous, making water communication a difficult matter. Outcrops are more abundant along the coasts, where they are not so effectively hidden by vegetation. Finally, no great central cordillera is known on Samar, with the result that a large amount of rain is evenly distributed over the entire island.

GEOLOGY

PETROGRAPHY AND GEOLOGY

The following notes on the petrography and geology of Samar are based upon a brief reconnaissance, for during this trip stress was laid upon economic features and only sufficient stratigraphy was undertaken to answer the economic questions involved. Were I asked to-day, "Is the island standing on end or is it flat?" I might say that I am not certain which is the case! Since the trip was merely a reconnaissance and no definite statements regarding broad structure can be made, it perhaps will be best for the reader to travel with the party on its various trips, and let me point out what was actually observed in the field and what laboratory study of the rocks and data brought out later.

Catbalogan and vicinity.—Our first work was done in the vicinity of Catbalogan, and there some interesting relationships were seen. For instance, a study of the formations in this neighborhood, strange to relate, showed the highly inclined strata on the beach to be post-Vigo formations, which are probably earlier than the less-contorted sandstone beds that apparently overlie them. Volcanic activity is evidenced by the presence of tuffs. The only pyroclastic rock collected by the party was taken from an outcrop of tuff on the beach north of Catbalogan, northwest of kilometer post 2 of the North Road. This tuff is a coarse-grained gray rock made up of angular fragments, among which magnetite was noted. A thin section shows abundant fragments of magnetite, some stains of hematite, and broken feldspar crystals in a siliceous matrix.

Still farther north an impure sandstone outcrops at a point 3.4 kilometers on the main road (locality F865). It is bluish gray, fine-grained, slightly calcareous, compact, and feldspathic. The grains are subangular, so that the rock approaches a grit. At the same locality, but overlying the gray series, are strata of impure, buff-colored sandstone that is more weathered. The fossils from these series include specimens of *Globigerina* and other Foraminifera, *Flabellum* (?), *Drillia* (?), immature *Cypraea, Turris,* and a form referred to *Cylichna.* They are

all very small and delicate, so that specific determinations are impossible.

Not unlike the above specimens is the sandstone occurring at locality F866, in Catbalogan, at the lighthouse, where the beds are so folded as to form minor anticlines and synclines. The specimen is fairly hard, compact, fine-grained, bluish gray rock, weathering brown. Magnetite and feldspar crystals were recognized among other subrounded grains. The fossils found in it were identified as *Drillia* sp. *a.*, *Dentalium*, *Nucula*, and *Nassa* (?).

Across a small bay from locality F865 at Maolong Point, near the municipal rock quarry, about 3 kilometers north of Catbalogan, are abundant outcrops. A rock from this locality near the water's edge is calcareous, medium- to fine-grained, and contains larger fragments of pure limestone. In it are to be recognized some magnetite, angular fragments of feldspar, and bits of subangular olivine, although most of the grains are more or less rounded. It is a fine-grained limestone conglomerate. Exposed at this locality is a hard, coarse-grained, compact, brecciallike rock, a coarse-grained limestone conglomerate. The specimen examined in the laboratory shows a rather unusual association of subrounded felsitic pebbles, fragments of magnetite, quartz (with a small fleck of gold), fractured feldspar, and, much to my surprise, *Lepidocyclina* and *Lithothamnium* in the larger angular fragments of limestone. In the field no recognition was made of the reworked nature of this formation, which was then considered to be Vigo (Miocene) in age. Here is, however, proof of a definite unconformity after Vigo time, and it further indicates that these beds on the beach are probably Pliocene in age. A soft, gray, medium-grained, foraminiferal rock is associated with these conglomerates at this place (F878).

At the top of the rock-quarry hill, only a short distance above these rocks on the beach, is a compact, fairly hard, dirty white limestone, relatively free from impurities, which is distinctly fossiliferous, as is shown by the presence of *Lepidocyclina* and *Lithothamnium* remains. This rock is, beyond doubt, Vigo. While in the field, we recognized that a fault had occurred here, but it was not until the laboratory study of the rocks had been made that the true significance of this fault was appreciated; that is to say, that the bearing the fault had on the unconformity here was defined.

One of the calcareous strata that outcrops at Anas Point, 2 kilometers northwest of Catbalogan, is a hard, compact, dark

gray rock. The angular to subrounded grains of this specimen consist of hornblende, hematite, phenocrysts of feldspar in small igneous pebbles, magnetite, and indeterminable minerals, bound together by a calcareous cement. This is a calcareous grit.

Another specimen from Anas Point (Station 12 + 10.6 H. G. S.) is a fine-grained gray rock that weathers yellow. Under the microscope it has a fragmental appearance; it contains magnetite, limestone, and also *Lepidocyclina* seemingly scattered through the rock, but I have little doubt that it is reworked calcareous sandstone.

Here (F879) likewise outcrops a clastic rock composed chiefly of limestone which, in the field, was thought to be an arkose. This is soft, fine- to medium-grained, light gray calcareous rock, containing fragments of feldspar and spotted by indeterminable, subangular black fragments. *Lithothamnium* and numerous Foraminifera occur in it.

A marl interbedded with a rather granular, compact, grayish white foraminiferal limestone, in which *Lepidocyclina* and the alga *Lithothamnium ramosissimum* Reuss were distinguished, also occurs at Anas Point. This marl is practically the same, even to fossil content, as that to be described from locality F868. The limestone may be fragmental.

Not far from this Anas Point locality on the beach, north 55° west of kilometer post 2 of the North Road, is an outcrop of limestone containing *Globigerina, Lepidocyclina formosa* Schlumberger (?), *Lithothamnium,* and *Lepidocyclina* cf. *gibbosa* Yabe, similar to the limestone at locality F868.

When the exposures southeast of Catbalogan are examined, rocks lithologically very similar to those already described from the region north of the provincial capitol probably will be noted. About 1 kilometer southeast of the town at locality F868 in the road cut (Plate 1, fig. 1) there is a good outcrop of a dull, chalky, calcareous, fine-grained, compact, soft, fossiliferous marl, containing abundant *Globigerina* but no *Lepidocyclina*. However, a similar marl occurs between the limestone beds in the formation at the same locality but on the beach. This limestone is in the same stratigraphic sequence as the marl and is blue-gray, mottled, fragmental or breccialike, and rich in *Globigerina, Lepidocyclina formosa* Schlumberger, indeterminable gastropods, and algal remains. From locality F869 (close to locality F868) is a yellowish white limestone, which is a little siliceous, but rich in foraminiferal and algal remains.

In general these beds southeast of Catbalogan dip to the northwest and strike northeast, but show considerable variation in both dip and strike within short distances, thus evidencing faulting. Apparently these beds, like those on the beach north of the town, are post-Vigo, and by their nature point to an unconformity between the Pliocene and the Miocene.

Gandara River.—From Catbalogan the party went to Calbayog and then up Gandara River to Matuguinao. Before going up the river, however, we spent a day or so in the vicinity of Calbayog, where we found that the hills southeast of Oquendo, north of Calbayog, present fairly abundant outcrops of lignitic sandstone, one specimen of which is a soft, fine-grained, noncalcareous, friable, buff sandstone. The traverse from Buao to Matuguinao disclosed flat, or nearly flat, outcrops of sandy clay-shale, or marl; while on the trip down the river, we saw evidence, though insufficient, of a westward-sloping monocline, which at places is possibly folded into minor shallow synclines and gentle anticlines, and at places is faulted. The majority of the strikes were northwest. The river in its upper reaches near Matuguinao meanders to a remarkable extent, but cuts through no limestone, although that formation is found at locality F877 near Matuguinao. This is a hard, white Miocene limestone containing *Lepidocyclina* and *Lithothamnium.*

Northeast of this interior barrio, at an elevation of about 400 meters, lying in close association with limestone, is a compact, brown-weathering, blue sandstone, medium-grained, calcareous, and consisting of angular to rounded grains, some of which are feldspar, quartz, and magnetite. It might be called a calcareous tuff.

Cross-island traverse.—The cross-island traverse did not disclose sufficient evidence to warrant any exact statement concerning stratigraphy or structure. It did indicate, however, that there is an igneous core to the island, and we were led strongly to suspect the existence of a basal igneous complex or a basement complex of metamorphics. This traverse is shown in Plate 4 with an explanation of the geological features. From these data an effort was made to construct a profile that would show, at a glance, the structure of the island; but it was found that the information at hand was insufficient to complete the picture, and the attempt was abandoned. I am led to the belief that the central portion of the island is composed, principally, of flat-lying beds of marl and sandstone of possible Pleistocene age and great masses of Miocene and Pliocene limestones

of unknown attitudes that at places project through the later cover or, perhaps, never were covered.

The starting point for this cross-island trip was Wright, or Paranas; the latter is the town's old name. Here there is a prominent cliff of typical marl, one specimen of which gave 27.65 per cent silica in addition to its calcium carbonate content. These Samar marls are usually gray, compact, lignitic, slightly feldspathic, shalelike in appearance, and contain minute, delicate fossils, among which can be recognized, from the beds at Wright, Foraminifera, *Dentalium* sp., *Natica* sp., hinges of a pelecypod, *Nassa* (?) young form, and *Yoldia* sp. (?).

On the road from Wright to Loquilocan outcrops of marl only were noted, and the definite attitudes indicate a north-south strike with a gentle dip to the west. Massive limestone was found near Loquilocan.

The hard, fine-grained red to brown fragments of jasper and chert that were noted in Ulot River point to the presence of chert and jasper in place—probably in the region near Lawaan, north of Loquilocan. No chert was seen in the streams that drain the west coast, and no quartzite at all was observed. It is interesting to note that some curious pottery and worked gold, which may be quite ancient, were found in the vicinity of Lawaan.

For a distance of about 2 kilometers, the course from Loquilocan to Bagakay was by baroto down Ulot River. Soon after we left the barrio, coal was noted outcropping on the bank of the stream. It is overlain by a very coarse, massive, gray calcareous sandstone, and is adjacent to some badly crushed clay-shale. Faulting is evident here.

In the bed of Ulot River, municipality of Wright, about 2 kilometers downstream (east) from Loquilocan, there is a small outcrop of a hard, fine-grained, compact, blue-gray rock, which is unstratified and amorphous and breaks with uneven fracture. In the field this rock was called a quartzite, and even under a hand lens it is certainly very similar to that metamorphic rock. However, a microscopic examination under low power shows a white thin section with black and white dots which are unchanged under crossed Nicols. The black components have a high refractive index. Relatively large phenocrysts of an indeterminable feldspar occur in a fine-grained groundmass of cryptocrystalline quartz, feldspar, and magnetite. This rock is a feldspar porphyry.

After leaving the boat and taking the trail once more, the course lay over limestone, but farther on shattered shale was again encountered, which, with clay, seems to be the principal geologic feature between Loquilocan and Bagakay, although a bowlder of an igneous rock was picked up in a stream between these two places, about 2 kilometers west of Bagakay. This proved to be a compact, fine-grained, dark gray rock, weathering to brown. Microscopically, it is a seriate porphyritic rock, tinged green by chlorite and composed chiefly of partially decomposed plagioclase feldspar, which occurs as lath-shaped simple and compound forms, and larger subhedral crystals, some of which exhibit wavy extinction. Olivine, augite, and chlorite are present. Although the hand specimen resembles andesite closely and the thin section shows some internal andesitic characteristics, this rock, because of its composition, is probably an olivine-basalt.[7] This may be the rock described by Roth as an augite-andesite or dolerite.

After leaving a settlement of two houses, east of Bagakay, the party observed in the bed of a creek a formation that is unmistakably igneous. It is a reddish rock composed of minute ferromagnesian crystals in a dense, vitreous groundmass, with many vugs filled with secondary material. It probably is an amygdaloidal basalt.

The rocks that were most puzzling in the field were specimens from the Wright-Taft trail, 5 to 6 kilometers east of Bagakay and less than half a kilometer from the basalt just described. Weathered specimens of this formation resemble sandstone, arkose, graywacke, or tuff, according to the mood of the observer at the time! At one place (station 30 H. G. S.), there is a definite outcrop which strikes north 45° west and dips 30° northeast. Megascopically, it is a medium-grained, blue-gray rock, and weathers to deep brown. It effervesces but slightly and is characterized by small, white feldspar and quartz crystals in a blue groundmass or matrix. Microscopically, it exhibits rather definite flow structure. It is composed of angular and subangular to rounded crystals, all well fractured and embedded in an apparently fine-textured matrix. Plagioclase feldspar predominates. On some of these crystals it is of interest to note intersecting brushes like an interference figure, showing that the minerals of this rock have undergone strain. It is possible that

[7] Cf. British Petrographic Nomenclature, Mining Mag. 24 (1921) 278–281.

this is an igneous rock that has undergone such pressure as to make it seem clastic. Some magnetite is present. However, despite its apparent clastic nature, I am inclined to designate this rock a dacite (?).

The first Malumbang (Pliocene) limestone to be recorded was found at locality F871. This, as well as the limestone at locality F872, farther east, on Malinao River, is yellow, argillaceous, and fossiliferous, yielding corals and mollusks, but is characterized by the absence of Foraminifera. In contrast to this are all the other limestones we have collected on the island and which are characterized by the inclusion of certain species of *Lepidocyclina* or other Foraminifera.

Between these two limestone localities, about 9 kilometers east of Bagakay, a specimen was picked up and labeled in the field, "Igneous, weathering to clay" because it was seen that the small core of an igneous rock had given rise to the clay which now surrounds it. A microscopic examination shows that the rock is characterized by small plagioclase crystals lying in a dense, glassy groundmass; a few small crystals, probably of hornblende; and some small vugs. On account of its texture and composition, I have classified it as basalt.

East coast.—From Marabgas, the party traveled in native dugout boats down Malinao (Tubig) River to Taft, which lies at the mouth of the river and on the Pacific Ocean. On the way we noted a soft, fine-grained, noncalcareous, argillaceous, tan-colored sandstone, which was badly weathered and contained many plant fragments. The grains are feldspathic to a large extent, are not well rounded, and are loosely consolidated. A clay-shale is also found along this river. On the north bank of the Malinao, opposite Taft, is an outcrop of massive marl, which lithologically is very similar to that at Wright. South of the town are several small, lunar bays, and at their horns' ends Recent coral occurs, while north of Taft to Dolores the trail lies along a narrow, sandy coastal plain.

Embayed and irregular shore lines and the drowning of Malinao River are evidences of subsidence in the vicinity of Taft and Dolores. Coral reefs, also, point to subsidence. Fig. 1 is a profile of the ocean floor east of Taft and shows a gently shelving platform to the 25-fathom line, where there is an upbuilding, then the depths become greater, with fluctuations, out to the Pacific Deep. Fig. 2 is a similar profile from Dolores to Hilaban Island and likewise may indicate subsidence. It is true that

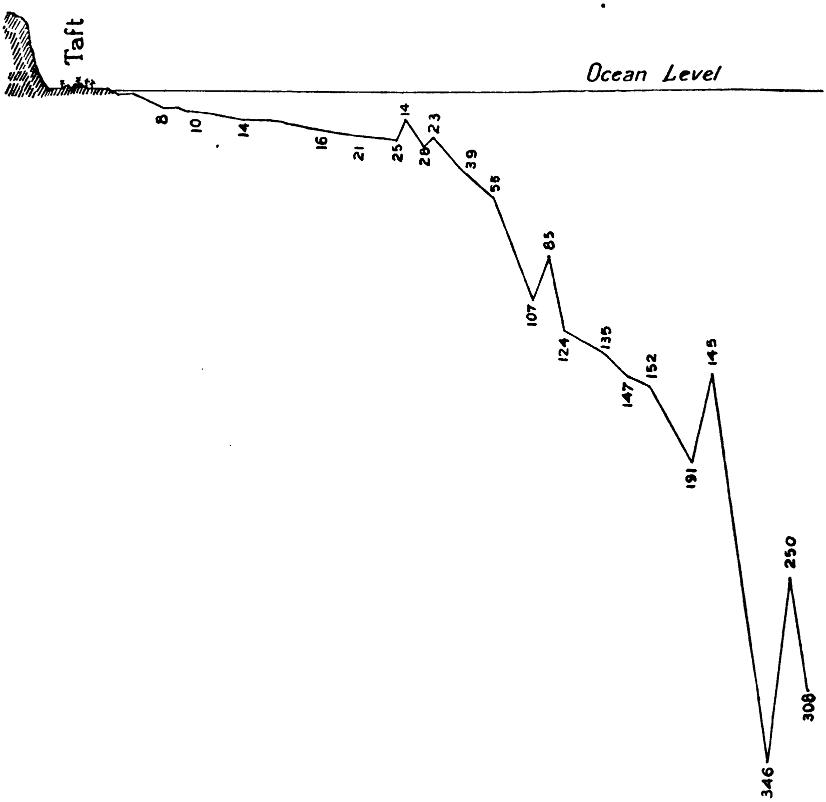


FIG. 1. Taft to the Pacific Ocean, Samar. Profile on east-west line; latitude 11° 54′ 48″, longitude 125° 25′ 30″. Scale: Horizontal about 1 : 150,000, vertical about × 6. Depths in fathoms, from Coast and Geodetic Survey sheet 1422.

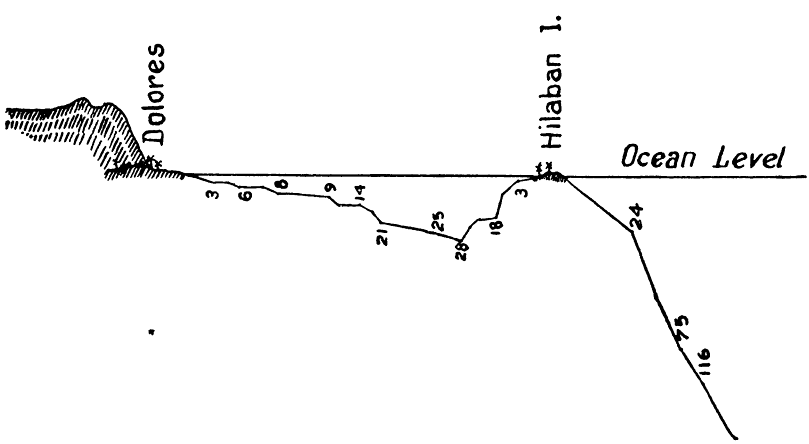


FIG. 2. Dolores to Hilaban Island, Samar. Profile on east-west line; latitude 12° 02′ 20″, longitude 125° 29′. Scale: Horizontal 1 : 150,000, vertical × 8. Depths in fathoms, from Coast and Geodetic Survey sheet 1422.

at this locality the evidence seems to favor the theory expressed by Davis that—[8]

The existence of earlier formed reefs at lower levels, now drowned, is highly probable on many of the Philippine Islands; for the absence of strong cliffs on headlands of their embayed shores indicated the presence of protecting reefs while the coasts were suffering erosion before their recent subsidence; thus, all the more does the absence of an extensive system of offshore barrier reefs, which should have grown up from the preexistent reefs during a slow subsidence, indicate that subsidence was more rapid than reef upgrowth. Moreover, the submarine platforms that border some of the islands are best explained as submerged and more or less aggraded reef plains, on the outer margin of which new barrier reefs have failed to reach the present surface because of rapid and recent subsidence; indeed, some of the platforms have no sign of upgrowing marginal reefs, and these must have been submerged with unusual rapidity at a very recent date.

Elsewhere Davis states:[9]

On the other hand, the northeastern coast of Samar, on the opposite side of the archipelago from Palawan, has a moderately sinuous shore line with delta flats that diminish the initial size of its bays, and fringing reefs that reach forward a mile or so from its points; here the latest submergence cannot be so recent as that of Palawan. But instead of being benched by a submerged platform, the sea bottom off shore from Samar sinks rapidly to a great depth.

As opposed to the theory of subsidence, Doctor Dickerson believes that Davis's conclusions were drawn too largely from the study of Palawan, and that it is possible for uplifts, instead of subsidence, to explain many, but not all, of these features. Dickerson says, in a personal communication:

Professor Davis' largely deductive studies based upon Coast and Geodetic Survey maps of the Philippine Islands are exceedingly suggestive and interesting. However, the Philippines have had a far more complicated history. Many of the islands have been uplifted independently of one another. Thus, studies on the northwest peninsula of Leyte indicate a highly complicated set of movements during the Pleistocene. Coralline limestone of probably Pleistocene age is frequently difficult to distinguish from similar limestone of Malumbang Pliocene age. In places, this Pleistocene limestone attains a possible thickness of 200 to 300 feet. At Rabin Point, northwest cape of Leyte, there are at least four terraces at approximate elevations of 15 feet, 100 feet, 200 feet, and 350 to 400 feet. When one traverses the terraces in the vicinity of Jubay, a small barrio on the west side of this peninsula, 2 kilometers south of Rabin Point, nothing but coralline limestone is observed. The top of the 200-foot terrace 2 kilometers south of Jubay is exceedingly even and is 3 to 4 kilo-

[8] Davis, W. M., Subsidence of reef-encircled islands, Bull. Geol. Soc. America 29 (1918) 517.

[9] Davis, W. M., Fringing reefs of the Philippine Islands, Proc. Nat. Acad. Sci. 4 (1918) 199.

meters in extent in an east-west direction. This thick coating of Pleistocene covers completely Vigo Miocene north of Mount Pampang. A few miles further south of Jubay at Daja, the unconformity between this Pleistocene limestone and steeply dipping beds of Vigo age is observed on the north side of Daja Bay. The terraces described in the vicinity of Rabin Point suggest uplifts or, if you wish to quibble, changes in level of the sea of considerable recency with periods of standstill during which such wide terraces as the 200-foot terrace at Rabin Point were formed. The 100-foot and 200-foot terraces appear to persist over the whole southwest side of Leyte. On the north headland of Tabango Bay, the 200-foot terrace is particularly pronounced. The 100-foot and 200-foot terraces occur likewise in the vicinity of Palompon and are probably present southeast of Maasin on the peninsula south of Baybay.

These terraces record, whatever their origin may be, uplift or change in level of the sea, but it is interesting to note that the latest movement in the region north of Palompon was a local depression. In the vicinity of San Isidro and Arevalo bays excellent proof of such condition is clearly evidenced.

In Bondoc Peninsula, a good Pleistocene fauna was recently collected from a terrace near Pinamuntangan Point at an elevation of 275 to 300 feet. Other evidences indicated still higher terraces in this peninsula.

Recent examinations along the southwest coast of Mindoro indicate extensive cliff sections, which at places for several miles defy the mariner to land. Similar cliff sections occur along Luzon in the vicinity of Manila Bay. In all cases where these cliffs are developed, the rock is compact and resistant to wave and stream erosion and the compactness of rock is the dominant feature of cliff development in the Philippines.

A distinct terrace at 2,000 feet approximate elevation is clear at the south end of Cebu Island, in the vicinity of Alegria. Both geological and biological data indicate that Cebu underwent changes quite distinctive from the neighboring islands of Leyte on the east and Negros on the west.

The party went from Dolores to Maslog by baroto and recorded, for the most part, only outcrops of impure sandstones, or marls, which also were similar to the marl found at Wright. Little more was noted between Maslog and Concepcion, as will be seen from an examination of fig. 3. At this point particular attention should be called to the long regular stretch of Dolores River from Hinolaso to Sumakay, to its long south-flowing tributary, and to a straight stretch of Ulot River corresponding to that of Dolores River. Farther east both rivers meander to a great extent. Assuming the presence of an elevated marine terrace and further assuming that these rivers are antecedent streams, this phenomenon is readily explained, though a low anticlinal structure might be the controlling factor. It has been pointed out that evidences of uplift have been noted at several localities—and the island shown in Plate 1, fig. 1, furnishes marked indication of a terrace—on the west coast of the

island, while definite evidence is not so marked on the Pacific side, although a recurring element [10] in profile of certain portions of the east coast, for example at Palapag Mesa, may point to uplift. Terracing may have been general in extent. I am convinced that the section of Samar just described represents an old Pleistocene marine terrace; should this prove to be the case, Dickerson's idea of extensive terracing would certainly carry considerable weight.

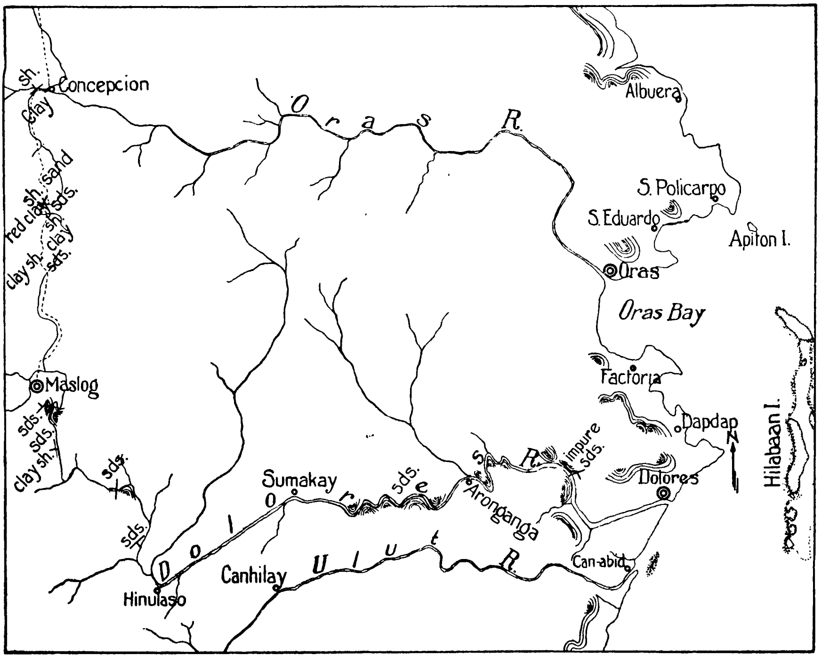


FIG. 3. Drainage control in a portion of the east coast of Samar.

It is on this northeast coast, also, that faulting is observed to some extent. A major fault line doubtless follows the seismotectonic line along the western coast from San Juanico Strait to the northwest corner of the island. The presence of another major fault line or fault zone running roughly parallel to the east coast and probably bounding the Philippine Deep seems to be strongly postulated by phenomena that occurred during recent earthquakes, of which Fr. M. Saderra Masó, S. J., of the Philippine Weather Bureau, writes:

[10] See Hobbs, W. H., Repeating patterns in the relief and in the structure of the land, Bull. Geol. Soc. America 22 (1911) 127.

EARTHQUAKES OF SAMAR, MAY 21 TO 26, 1921

On the afternoon of the said date at 12.45:5 a foreshock of intensity IV–V was felt throughout Samar, and as far as Catanduanes, Sorsogon, and Albay. At 16.43:21 occurred the principal earthquake, which at Batag affected the lighthouse apparatus, so that afterwards it refused to turn: no other damage was reported; yet the intensity of the shock must have reached degree VII at least. The observer at Batag reports that the jerks, both of the principal shock and of the preceding one, were in a nearly east-southeast and west-northwest direction. This earthquake shook Samar, Leyte, Masbate, and Catanduanes Islands and the southeast provinces of Luzon, Sorsogon, Albay, Camarines Sur, and Camarines Norte.

The quake was followed by a series of aftershocks, which did not cease until the 26th. Our seismographs at Manila recorded seven on the 21st, seven on the 22d, eight on the 23d, but two on the 24th, three on the 25th, and two on the 26th. The seismograph at Tigaon, Camarines Sur, recorded some few more; the seismograph of Butuan did the same. Of these twenty-nine aftershocks recorded at Manila, only fourteen were felt at Catbalogan (Batag did not send detailed list, the report says that light aftershocks occurred at intervals); Legaspi and Calbayog felt eight. In the whole series, three only reached degree IV.

The origin of the disturbance lay certainly outside of Samar under the sea. Our records give an average distance of 550 kilometers from Manila; such a distance places the center at about 50 kilometers from the northeast portion of Samar, fully in the Philippine Deep.

October 19, 1897, there occurred in the same region a much-stronger earthquake, which caused considerable damage in the towns of Laoang, Palapag, Oras, Sulat, Gandara, and Catubig: the aftershocks were frequent at Laoang until March, 1898. The epicenter was presumably likewise in the Deep.

The anomaly of Calbayog, with only eight aftershocks, while Catbalogan felt fourteen, is in accordance with what happened in other instances. Calbayog seems reluctant to be shaken; perhaps the geological conditions might give some explanation.

An explanation of this anomaly might be the distribution of rainfall connected with the nature of the formations near Catbalogan; that is to say, the loosely consolidated sediments near Catbalogan when they are water-soaked would make the earthquake shocks more apparent than the less-saturated beds at Calbayog.

Jipapad to Laoang.—The trail from Jipapad to San Vicente extends across several ridges of sandstone and shale, and no other formation was seen during the entire journey from the latter barrio down Catubig River to the town of Catubig. At this town, there is a concrete pavement containing igneous pebbles, and inquiry showed that these were obtained from a branch of the river that flows from the southwest. Clay and alluvium, only, are exposed by the river between Catubig and Laoang, on

the north coast. In 1907, Lieut. Robert Thomas collected three rock specimens from northern Samar and submitted them to the Bureau of Science with a memorandum of localities. To-day only the memorandum can be found. Specimen 1 was a carbonaceous shale which is common in Catubig River Valley. No. 2 was a diorite (quartz?) found in the bed of Palapag River near the town of Palapag. The collector notes: "No stratum found anywhere in river bed." Specimen 3 was a quartz pebble found near the mouth of Palapag River. The diorite, it is thought, points to a dioritic basement complex of Samar.

North coast.—Outcrops, probably of post-Vigo formations, at Laoang strike approximately east–west and, according to Moody, dip north. Farther to the west, near the Catarman Agricultural School, strata of shale, sandstone, and conglomerate, with intergradations, were seen. A specimen of impure sandstone from this locality is medium-grained, buff, heavy-bedded, slightly calcareous, somewhat feldspathic, discolored by iron, and composed of fairly well-rounded grains. The shale is bluish, weathering to buff, while the conglomerate is composed principally of diabase, diorite, felsite, and quartz pebbles, subangular to rounded, averaging 1 to 2 centimeters in diameter, embedded in a gritty, calcareous matrix.

On the north coast of Samar, 2 kilometers east of Carangian, is an outcrop of a badly weathered, coarse-grained, gray rock, which is discolored by iron and speckled with black crystals of pyroxene and many fragments of magnetite. The grains are not well rounded, and though some augite is present, the principal minerals appear to be quartz and feldspar, making the rock an arkosic sandstone or, perhaps more properly, a true arkose. I am led to speculate if this formation explains the statement made by Becker to the effect that—[11]

> In Samar, Jagor found no ancient rocks in place, but sediments which he collected on the north coast appeared to Roth to be derived from gneiss or mica schist.[12]

Moody also collected a specimen of this rock from the same locality, but on the beach; it is rich in feldspar and magnetite, with a little biotite, and appears to be a badly weathered, holocrystalline, igneous rock; if it is, one could say with some certainty that this represents the basement complex of the island,

[11] Becker, G. F., Geology of the Philippine Islands, Annual Rep. U. S. Geol. Surv. 21 [3] (1901) 493–644.

[12] Cf. translation of Roth's paper, Appendix 1, page 263.

and from the nature of these earlier formations one would not expect to find the Vigo and later sandstones anything but the predominantly feldspathic rocks that they are. The interesting feature of this rock, Moody states, is that it is here interbedded with a green shale. This is a slightly calcareous, fine-grained rock, which resembles a jointed clay. No fossils were noted in it.

Balicuatro Point, as observed from a launch, probably is formed of basalt, in part, since the rocks forming it appeared to have the color of that rock and at one place seemed to exhibit characteristic columns of basalt.

Basey to Calbiga and Catbalogan.—The final trip was by launch from Basey to Catbalogan, via Calbiga. A specimen of compact, clean white, foraminiferal limestone, probably Miocene in age, was collected from the seacoast at the sitio of Hilaba, municipality of Basey. This rock is quite free from detrital impurities.

The prominent hill southwest of Basey, southern coast of Samar, is made up in part of conglomerate, a speckled gray, somewhat calcareous, coarse rock in which pebbles of an igneous character, slate, secondary quartz, and fragments of magnetite are distinguishable. The pebbles average less than 1 centimeter in diameter. This conglomerate overlies faulted sandstones and shales of possible Vigo age. It probably is a purely local conglomerate.

In passing through San Juanico Strait, sedimentary beds are seen on each side, though some igneous rocks occur. There is only one rock from Samar in the Bureau of Science collection that was not collected by our party, and this specimen is one that dates from the Spanish régime. It is labeled "traquita anfibolifera" (amphibole trachyte) and is from visita Nabatas, municipality of Villareal, south of Talalora, at the northern end of San Juanico Strait. This rock is dark gray, fine-grained, and compact. Thin sections show that the principal phenocrysts are hornblende and glassy feldspars, though some augite is present, as well as grains of magnetite. The groundmass is made up chiefly of minute crystals of feldspars of another generation than the larger feldspar phenocrysts. This trachyte is similar to a hornblende-andesite from Caibiran on the east coast of Biliran Island.

A noncalcareous clastic rock outcrops at Cologdog Point, near the northern entrance of this channel, and near the town of Talalora. The rock is very fine-grained, compact, buff sand-

stone made up of rounded grains (with a few angular fragments) in a siliceous matrix. Magnetite and feldspar are present.

Interbedded with this sandstone is a medium-grained, compact, light gray calcareous rock, in which specimens of *Lepidocyclina* can be recognized in the limestone fragments between subangular crystals of feldspar, hornblende, olivine, and magnetite. It is an impure sandstone that strikes about north–south, dips at a high angle to the west, and is post-Vigo in age.

In going from Talalora to Calbiga by launch, several limestone islands are passed. Caves on some of these islands were used by the early inhabitants of Samar as burial places. Mr. Joseph Motak, of Catbalogan, presented me with a deformed human skull which he found in a cave on Awacan (Aocon?) Island, near Villareal. The chapel cave, from which Mr. Dean C. Worcester and others made an interesting anthropological collection within the last few years, is in this neighborhood.

Concerning this portion of the coast, Adams says:[13]

> In traveling by steamer from Catbalogan, Samar, to Carigara, Leyte, and returning from Tacloban through the straits and interisland passages to Catbalogan, an opportunity was given to see the islands at close range, but no landing was made. The islands consist of sedimentary rocks with some igneous rocks which appear to form the axis of the trend, and, if they are not a continuation of the igneous rocks of northeastern Leyte, they at least follow structural lines. * * * These [sedimentary beds] are imperfect sandstones and nodular and concretionary argillaceous beds.

Adams states that the outcrops dip at low angles to the eastward. To verify these statements will take more detailed field work, but from what has been stated already, it will be seen that Adams's generalizations may not be fully justified.

Good specimens of marl come from the vicinity of Otoc, near Calbiga, while in the bed of Palongi Creek, near the town (station 45 H. G. S.) is a hard, gray arkosic sandstone, speckled with black dots. It is compact, medium-grained, and made up of angular to subrounded grains of magnetite, hornblende, feldspar, and secondary calcite.

Petrography.—The detailed study of the rocks of Samar brought out several points, which will be reviewed here. The changes in thickness of sedimentary beds varies within short distances, and torrential rains of the earlier periods doubtless

[13] Adams, G. I., Geological reconnaissance of the Island of Leyte—with notes and observations on the adjacent smaller islands and southwestern Samar, Philip. Journ. Sci. § A 4 (1909) 351, 352.

caused the confusing heterogeneity of sedimentation observed to-day in the Tropics. There is not a great variety of minerals making up the various sedimentary formations. Almost without exception, these rocks are calcareous and the sandstones are not made up of pure quartz grains; instead, feldspar predominates. Because of this, the grains vary in size and shape and lack the well-rounded appearance of true sandstone grains. This is what one would expect, considering that not one of the igneous rocks noted is definitely acidic in character, and that the basement complex is probably dioritic in character. The reworked Vigo rocks indicate a period of erosion after the Miocene.

Structure.—An insufficient amount of definite information was obtained by the reconnaissance party to work out, in any detail, the broad structural relationships of the land, and before any conclusions can be reached several very important points must be determined. Among the things that remain to be determined or about which some doubt now exists are: The extent of the Miocene beds, the presence of unconformities, the distribution of igneous rocks, the time of earth movements, whether marine terraces are local or general in extent, the lines of major faulting and folding, and whether or not the island has been differentially tilted. The data now in hand are sufficient for economic purposes and show, among other things, that the island has an igneous core; that there are some monoclinal strata, minor folds, much faulting, and unconformity after the Vigo Miocene. The information also indicates other suspected unconformities, a definite topographic unconformity between the Pleistocene and Recent formations, and complex earth movements.

HISTORICAL GEOLOGY

The ups and downs of Samar have been many. They began in pre-Miocene times and continue at the present day. To write a complete and accurate geologic history of the island is well-nigh impossible; but it is not impossible to recount a few of the principal happenings and to show how the predominant and characteristic fossil life, as preserved, belongs to the Foraminifera. The geologic relationships herein set forth are tentative only.

The existence of pre-Tertiary formations is inferred, but not certain. Evidence points to what may be metamorphosed sediments, as well as basic igneous material, as the basement complex of Samar; and a great deal of evidence, both botanical and zoological, points to a former land connection of the Philippines with other islands. For instance, plant affinities of the outer arc

of the Philippines (eastern Mindanao, Samar, and eastern Luzon) are much closer with Celebes, the Moluccas, and New Guinea than with any part of the Sunda group (Sumatra, Java, Borneo).[14] It may be, then, that in pre-Tertiary times, Samar was connected with other land masses, although it likewise is probable that a separate island then existed and a connection came later. But, whenever the separation occurred, it seems definite that upon the basement complex were laid various sediments, in a manner similar to the sedimentation of to-day.

The Miocene formations consist of the earliest unaltered sedimentary rocks. As a rule, the sandstone beds contain few fossils, but the limestones are rich in *Lepidocyclina*. Under the microscope, one recognizes this small marine animal by its attenuated ends and bulging center; by the "medial plane composed of chamberlets arranged in regular annuli around a distinct central chamber or chambers. The genus has lozenge-shaped or spatulate-formed chamberlets." (Chapman.) Cushman [15] thinks that in America this genus ranges no higher than the Oligocene; but in the Philippines the presence of *Lepidocyclina* has been found to indicate Miocene strata, with probably no range into the younger formations.[16] That the genus has a short vertical range is not doubted, and it is thought that the small forms found in Samar rocks indicate middle and upper Miocene deposits. While the Miocene limestones are rich in this index fossil, coral remains are astonishingly meager.

While limestone was being formed, the old basement complex of the island was suffering erosion. Feldspathic sands and clay were being carried into the seas, mixed with calcareous and lignitic material, and consolidated, and finally the beds were uplifted and folded, perhaps with the aid of volcanic intrusions.

Following the Miocene was a long interval of quiet water deposition and an equally marked period of erosion of the Miocene beds. The limestone of the Ep-Pliocene contains abundant mollusks and corals. Although the genus *Lepidocyclina* had by that time become extinct, other Foraminifera still abounded in

[14] According to E. D. Merrill, in a personal communication.

[15] Cushman, J. A., American species of Orthophragmina and Lepidocyclina, Prof. Paper U. S. Geol. Surv. 125–D (1920).

[16] See Douvillé, Henri, Les Foraminiféres dans le Tertiaire des Philippines, Philip. Journ. Sci. § A 6 (1911) 53; Smith, Warren D., Contributions to the stratigraphy and fossil invertebrate fauna, Philip. Journ. Sci. § A 8 (1913) 235; Yabe, H., Notes on a Lepidocyclina-limestone from Cebu, Science Reports Tohoku Imperial University, II (Geology) 5 [2] (1919).

the seas. At places, Miocene limestone must have stood out as prominent headlands. The wave action that wore away the rock partially rounded the fragments that contained this characteristic Miocene fossil, and then cemented a new rock, including in the product rounded pebbles of igneous formations; or it may be that at places the burden of the streams failed of influence, and there was formed, instead, a new limestone out of the fragments. Stream action may have accomplished the same results.

The Pliocene was followed by an interval of erosion. In the Pleistocene seas corals again lived, and in these waters marls, shales, and sandstones were consolidated. During this period the marine terracing took place and subsidence of portions of the island occurred.

The Pleistocene is separated from the Recent by a marked topographic unconformity, and in this, the latest time, the dominant features again appear to be uplift, subsidence, and the growth of reef corals; and to-day Samar is subjected to great erosion accompanied by the conveyance of vast quantities of material by the numerous streams into bays such as the one at Wright, which is being filled gradually. Thus, youthful are transformed into mature shore lines. If we project the conditions of to-day into the past, we find warrant for the belief that in late Tertiary and Recent times Samar has been unstable and that life in the shallow waters bordering the coast has always been abundant.

ECONOMIC GEOLOGY

It has been pointed out that the ragged island of Samar is of relatively recent origin and that sedimentary rocks are by far the most abundant ones. The economic mineral products of Samar remain to be discussed under metallic and nonmetallic minerals. A summary of this entire subject is simple and may be expressed by the statement: "No commercial deposits were encountered."

Metallic minerals.—Our party found no important economic metallic minerals in Samar, and this is what would be expected, judging from the character of the formations observed. Gold has been reported from the mouth of Pambujan River and from other streams, but the only gold seen by me was a microscopic fleck in a reworked limestone conglomerate. Copper is reported on Capul Island. It is said that lead occurs at places. I saw no formations that hold any promise of metallic productivity. It must be borne in mind, however, that the reconnaissance did

not include a trip to the northwest corner of the island. When one considers, moreover, the labor and market conditions, the cost of supplies and transportation, and taxation, it is evident that Samar is not a favorable field for activity in the mining of metallic minerals.

Nonmetallic minerals.—The general conclusions with regard to metallic minerals hold true with reference to the nonmetallic ones. However, realizing that in some cases negative information is as valuable as positive, I desire to call attention to the economic possibilities of coal, petroleum, stone, clay, rock, and gravel, and artesian water in Samar.

Coal.—Samar coal is still too "green" to be of much value, and the seams are not of sufficient size to warrant mining at the present time. Two samples, whose analyses are given in Dalburg's paper on the coal resources of the Philippines [17] show the following:

TABLE 1.—*Analyses of Samar coal.*

Source of sample.	Moisture.	Volatile.	Fixed carbon.	Ash.	Sulphur.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Wright (Paranas) [a]	16.78	37.75	36.53	9.54	2.32
Llorente [a]	12.43	31.43	30.46	25.68	10.57
Liguan (East Batan) [b]	6.08	40.36	51.24	2.32	0.40

[a] It is not known if these are outcrop samples. [b] For comparison.

The comment that this lignite from Samar is a poor grade of coal is hardly necessary. No good prospects were noted, although on its cross-island trip, the party found specimens of woody lignite at various places between Loquilocan and Bagakay, and in the clay beds of most of the rivers one can pick up much lignitic material. Outcrops also were seen on Calbiga River, typically near Otoc; on Gandara River; and near Oquendo, on the west coast. The coal probably was deposited in local Pliocene [18] or later basins, and frequently the deposition was during torrential rains, so it would not be at all surprising if the beds thicken and thin to some degree. Faulting of the seams was observed. Therefore, the coal of Samar, in addition to being of poor grade, is geologically unfavorable for development.

[17] Dalburg, F. A., Mineral Resources of the Philippine Islands for the year 1911. Manila (1912) 62.

[18] *Vicarya callosa* Jenk., a good coal-horizon index fossil, was not noted in any of the formations.

Coal has been reported from various localities. Becker says:[19]

> In Sámar, according to Centeno, the coal deposits of Sorsogon continue. He gives a locality, Loquilocon, and Mr. Abella mentions Gándara and Paranas. The last two towns are on the west coast, at a considerable interval. A line drawn through them would pass near Gatbó, and its direction would be very like the strike of the bed at the last-mentioned place, differing some 60° from the prevalent strike in Cebú.[20]

Residents of Samar report coal from Borongan; Catarman River, near Lope de Vega; and other localities, making it apparent that Becker based his conclusions upon too little evidence.

Petroleum.—Samar, in the part visited by us, is considered an unfavorable field for the accumulation of a commercial supply of petroleum. This is based upon the following: First, no seep was seen and none was reported to us; at places where one might expect to find seepages, nothing is seen resembling petroleum or even suggesting it. Second, structure suitable for the accumulation of a commercial supply of petroleum was not encountered. Furthermore, the conditions of quiet, shallow, and stagnant water deposition during much of the history of the island, and the presence of resin and lignite in the different beds, make it improbable that petroleum exists in Samar.

Stone.—The cost of stone depends, among other factors, upon its availability and its workability. In Samar, as has been noted, the most probable markets for any stone are the towns along the coast, which are situated at some distance from the supply; that is, the neighboring islands or the interior of the island. There is no sandstone that would serve as a good building stone, no roofing material, and no granite. The limestone, with a probable life of twenty to forty years in a drier climate, is frequently too soft to be of much use and, furthermore, it probably would be difficult to quarry. Coralline limestone and fragments of coral have been utilized as building stone in the construction of some of the churches. Because these materials weather rapidly, a false impression of great antiquity of the building is produced. Samar in its present stage of development would offer a poor field for the quarryman, since the stone that is found there is not readily available and is not of excellent quality.

[19] Becker, G. F., Geology of the Philippine Islands, Annual Rep. U. S. Geol. Surv. 21[3] (1899–1900) 571.

[20] Strike at Gatbo, north 20° west.

Rock, sand, and gravel.—I saw no good quartz sand in Samar. It is true that sand occurs, but the grains are angular and feldspathic. The fact that the concrete street at Catubig contains igneous pebbles and bowlders has been stated. That there are no deposits of good sand and gravel is not surprising when one considers the nature of the country rock and the history of the island. Igneous rock for road metal is difficult to obtain.

The rock, sand, and gravel used on the roads of Samar in 1920, according to an official report, amounted to 8,474.57 cubic meters, costing 24,963.22 pesos. The coralline limestone cost 5 pesos per cubic meter, and gravel as high as 7 pesos per cubic meter, while the lowest figure was 1 peso per unit for coral.

For purposes of comparison Table 2 is given.

TABLE 2.—*Rock, sand, and gravel used in the Philippines during 1920.*

Locality.	Amount.	Cost.	Average cost per cubic meter.
	cu. m.	*Pesos.*	*Pesos.*
City of Manila	65,525.05	94,731.73	1.45
Cebu	10,342.72	17,948.13	1.93
Rizal	9,947.00	28,343.30	2.85
Samar	8,474.57	24,963.22	2.95
Pampanga	6,116.52	27,740.00	4.53

Clay.—A sample of clay from near Matuguinao, at a place locally called "Fairy Land," shows the following:

TABLE 3.—*Analysis of clay sample from Matuguinao.*[a]

	Per cent.
Loss on ignition	47.50
Silica, SiO_2	26.37
Ferric oxide, Fe_2O_3	10.64
Alumina, Al_2O_3	13.20
Lime, CaO	0.21
Magnesia, MgO	1.57
Potassium oxide, K_2O	0.21
Sodium oxide, Na_2O	0.49

[a] Analysis by R. H. Aguilar, Bureau of Science.

This probably is a residual clay, low in silica and relatively high in iron. It is plastic, but would not make a satisfactory china clay; at best it would yield only an inferior building brick. I saw no deposit of good clay.

Artesian water.—In 1909, George I. Adams, geologist in the Bureau of Science, submitted a report on conditions governing

the drilling of deep wells at Catbalogan and Calbayog. This report was not intended for publication, but I am taking the liberty of quoting a few of Adams's conclusions:

The fact of the existence of the springs to the south of the town (Catbalogan) suggests that the formation above sea level retains good water. It may be that the formation below sea level also contains good water, but until a test is made this cannot be determined. If it is decided to drill a well at Catbalogan, it would be advisable to place it inland at the base of the hills southeast of the town so that a reservoir could be placed on the hillside and a gravity system be installed in case a good supply of water were encountered. In drilling at Catbalogan a heavy rig will be required.

If a well is drilled at Calbayog, it is recommended that it be placed at the base of the hills northeast of the town, direction north 60° east from the church. It would accordingly be located about five blocks from the edge of the town. The adjacent hills would furnish a reservoir site and allow of the installation of a gravity system by pumping from the well. It may be that the formation of the west coast of Samar contains salt water below sea level and that the well at the locality above mentioned would encounter salt water, but if so, the experiment would condemn a large extent of the coast where wells must obtain water below sea level.

From the information concerning the mineral resources of Samar now in our possession, the conclusion may be drawn that it is an unpromising field for any activity in this line. Many minerals, including gold, copper, lead, graphite, and phosphate, are much talked about, but no specimens were shown to us. Our informants assured us that "if they were sure they would get something out of it" they could readily prove their statements. Of course, further prospecting may bring to light minerals that are more accessible and perhaps in some quantity, but Samar at present does not appear to be a rich mineralogic province.

APPENDIX 1

[Translated from Ueber die geologische Beschaffenheit der Philippinen, by J. Roth, Appendix II to Jagor's Reisen in den Philippinen. Berlin (1873) 351-354.]

In the Catarman River (north coast of the island) between Catarman and Cobo-Cobo, there are rather compact, ferruginous clay banks of a light brown color, without lime but containing remains of carbonized plants and also numerous bore-holes, which, according to Dr. von Martens, are caused by *Modiola striatula* Hanley which is often present in the holes. After elutriation, the clays leave a varying residue composed of quartz, partly in ferruginous rounded grains and partly as angular splinters; some magnetite; white, gray, and green mica; and feldspar. Some brown, ferruginous layers of almost pure sand of rather large grains exhibit the same composition. Similar, but green, sandy layers occur farther upstream in Catarman River. After treating with hydrochloric acid, one notes in the sediment besides magnetite much white quartz, here and there with

some dark mica; also feldspar and white and dark scales of mica. On the Salta Sangley, farther south, occur blue-gray clay banks made up of sandy, greenish layers which contain the same minerals. In the river starting farther south and near Salta Sangley and flowing from the rectory at Tragbukan to Calbayog, are found soft, rounded bowlders of a badly weathered rock, coming from the headwaters of the river. In it are recognized white, and some dark, mica and it contains, after washing the clay away, a sediment of, in part, ferruginous quartz, feldspar, and some magnetite. Accordingly, these bowlders probably come from a gneiss or feldspar-rich mica-schist.

Farther downstream below the Tragbukan chapel there appear again green and brown, ferruginous sandstones, slightly consolidated, and made up of coarse grains, and having the composition already mentioned. This relationship shows that these banks, as those above mentioned, came from a weathered gneiss or feldspar-rich mica-schist. In all these clay and sandstone strata there is no larger fragment of rock which would throw more light on the subject.

Still farther downstream are brown, fine-earthy, compact, calcareous clay banks, with indistinct petrifactions. The residue after treating with hydrochloric acid, shows only some scales of mica and quartz grains.

Farther southeast on the coast near Catbalogan and on the neighboring Mojava Island appear volcanic tuffs. These are rather compact, slightly clayey, coarse-grained, and greenish gray in color. They contain, besides numerous fragments of augite, some rounded crystals of this mineral, much magnetite, white feldspar, and some pieces of stone which are the same as some of the foregoing larger fragments of rock. The gray, thick, compact rock contains in a feldspathic groundmass much green augite and separate crystals of magnetite. After treating with boiling hydrochloric acid, the groundmass becomes white and is strongly attacked. This behavior and the very small number of small triclinic feldspar crystals show that the rock has come from a porphyritic dolerite or pyroxene-andesite. A rounded bowlder taken from the same block of conglomerate carries green augite in the thick brown groundmass. The numerous round cavities are filled with stilbite and opal; the tuffs have a hardness of 2.5 and dip 80° north.

At Catbalogan we find gray and brown banks, which are somewhat argillaceous, partly consisting of very fine sand. The powder yields magnetic iron to a magnet. They (the banks) sparingly contain triclinic feldspar, augite, and fragments resembling pumice, sometimes also fragments of a very dark, thick rock in which can be recognized single triclinic feldspar crystals. In connection with the origin of Mojava, these formations may be considered as derived from doleritic rocks.

These banks were in part overlain by a layer of soft, yellowish gray, fine-grained limestone. The latter, on treatment with hydrochloric acid, leaves a residue consisting of numerous clayish particles, some feldspar, augite, and magnetic iron, and small, gray particles of stone; in part, calcareous sediments, which have a hardness of 5 to 5.5 and dip 35° north, and are thick, compact, and light gray in color. The lower layers are mixed with volcanic tuff and calcareous sediment.

Close to the seacoast near Paranas [Wright] to the east of the bay, one notes a hard shell breccia; that is, shell fragments cemented with lime, in large, crushed bowlders lying on softer banks of the same material. Out

of the latter one can recognize, according to Dr. von Martens, among the numerous shell fragments, *Plicatula depressa* Lamarck, which is still living in the Indian Ocean. The yellowish gray clay banks under these horizontal layers dip inland. According to Dr. von Martens, from among the fairly well-preserved shells and pteropods, one can identify, in part, the following species [genera]: *Yoldia, Pleurotoma, Cuvieria, Creseis, Dentalium*, which still live in the Indian Ocean. The species *Pleurotoma* is not identified with any one living species. With the living species can be recognized the following: *Venus* (*Hemitapes*) *hiatina* Lam., *Venus squamosa* L., *Arca* (*Scapharca*) *cecillei* Phil., *Arca inaequivalvis* Brug. var.,[21] *Arca chelcanthum* Rv.?, *Corbula crassa* Rv., and *Natica unifasciata* Lam. var. *lurida* Phil.

In the forest between Paranas and Loquilocan which stretches to the northeast and toward the land are cliffs of solid, grayish white limestone, resembling conglomerate, interwoven with veins of calcareous spar (calcite) and in which may be recognized indistinct organic remains, perhaps of corals. In the Loquilocun River, which directs its course toward the northeast to the east coast of the island, there are, below the Loquilocun chapel, brownish yellow, badly weathered calcareous sediments in great unstratified masses. The coal which forms an alluvial deposit near the sixth rapids below Loquilocun is rich in pyrites and interwoven with gypsum, and is similar to the wood of lignite. Its woody structure can be seen with the naked eye and it gives a brown powder.

From a large alluvial deposit of gravel and rubble opposite the rapids below Loquilocun, where the boat must be unloaded for the first time and the cargo carried overland, can be obtained the following: (1) A much-altered, granular, red-gray rock veined with epidote; in it can be seen, besides quartz and triclinic feldspar, a fair number of points of magnetite; it does not impress one as an eruptive rock and could belong to the feldspar series of hornblende-schists; (2) a blue-gray, porphyritic rock whose vitreous groundmass (lacking the property of double refraction) is filled with small sphalerites and contains sparingly small grains of quartz and magnetite, besides larger dull white feldspars. Only on one of the crystals could the triclinic bands be recognized with certainty. The rock is probably a recent eruptive but a further classification is doubtful; at any rate, the presence of quartz in the vitreous groundmass is of interest. The grains of quartz cannot be considered as incrustations; (3) farther on is an agate of milky white color, one of the amygdaloids, as the surface proves; (4) red-brown jasper interwoven with fine quartz veins.

Bowlders from Basey River (southern coast of the island) accumulated at the Sogoton cave, are composed of an old eruptive rock. It contains in a fine-grained dark green groundmass dull white feldspar, a little magnetite, and some indeterminate greenish crystals, which may be considered to be augite. Conforming to this composition and the behavior of the rock and the feldspars with boiling hydrochloric acid, the rock belongs to an oligoclase-augite-porphyry. The red-brown, ferruginous soft rock which occurs near the preceding one and which effervesces in acids and

[21] The teeth are somewhat more numerous and smaller than in *A. aequivalvis* Brug. Jagor, Philippinen.

with a feldspar that acids decompose completely, may be a tuff coming from a similar porphyry. In the bed of Sogoton River north of Basey are bowlders of talc- and chlorite-rocks.

The Sogoton cave is formed of calcareous cliffs in which one recognizes traces of bivalves and spines of echinoderms. In front of the grotto are situated, at a height of 20 feet [about 6 meters] above the river on the right bank, banks with marine shells. There are species still living; according to Dr. von Martens, *Venus* (*Hemitapes*) *hiatina* Lam., *Arca* (*Scapharca*) *cecillei* Phil., *Arca uropygmelana* Bory, and *Placuna placenta* L. The shells scarcely adhere to the tongue; therefore, the deposit must be very recent. On one of the small islands near Nipa-Nipa (Basey) are found, on the raised shell banks situated at a height of 60 feet [about 20 meters] above sea level, the following living species (according to Dr. von Martens); *Chama sulfurea* Rv., *Pinna* cf. *nigrina* Lam., *Ostrea denticulata* Born, *O. cornucopiae* Chemn., and *O. rosacea* Desch. On the coast west of Basey is an incoherent aggregate of shell fragments with isolated, rounded, small bowlders.

APPENDIX 2

FOSSIL LOCALITIES, SAMAR ISLAND

Locality F865.—Catbalogan, 3.4 kilometers north of the town, on main road, south 40° west across bay from quarry and about 0.5 kilometer north of barrio of Maolong. Prominent exposure of gray sandstone overlaid by buff sandstone, with small normal fault in approximate center. Strike north 10° west, dip 6° northeast, with doubtful plunge of 4° northwest. Alternate layers of sandy material in sandy shale. Lower series contains small, poorly preserved fossils and some carbonaceous material, including pockets of amber. Small, thin laminæ and strata average approximately 15 centimeters. Deeply weathered. Upper series, compact, fine-grained, buff, calcareous sandstone, which is fossiliferous (contains *Globigerina*) and carbonaceous. This locality is readily identifiable by fault. The height of exposure is about 6 meters, though in the immediate neighborhood this figure will vary from 0.5 to perhaps 10 meters. The road cuts nearly along the strike of beds. Collector, H. G. Schenck, November 1, 1920.

Locality F866.—Catbalogan, on right bank of Antiao (Catbalogan) River, between suspension bridge at north end of Calle del Rosario and mouth of river and continuing around Light House Point. Exposures of sandstone varying in texture from sandy shale to buff, compact, hard sandstone, each stratum averaging about 3 decimeters in thickness. Fossils small and poorly preserved, falling to pieces upon exposure. Strike east and west, dip 15° northeast. Small fault in exposure, dying out in upper beds. Beds exposed by tide; strike north 87° west, dip 21° northeast. Outcrops sandstone and shale upstream to point 200 meters from mouth have varying strike. Small, well-defined folds, making series of plunging anticlines and synclines, occur at locality. Collector, H. G. Schenck, November 2, 1920.

Locality F867.—Lepidocyclinal limestone on south-southwest side of quarry hill on beach approximately north 55° west from kilometer 2 post, Catbalogan North Road. Fine- to medium-grained sandstone, and sandy

shale seem to grade into conglomeratic limestone, striking north 30° west. Stratigraphically above this limestone is a fine-grained buff sandstone, containing some carbonaceous matter and amber. Higher in series are white shale (marl?) and heavy-bedded, medium-grained, buff sandstone. All beds dipping at high angle. Above sandstone is a calcareous sandstone. Collector, H. G. Schenck, November 4, 1920.

Locality F868.—Catbalogan, about 1 kilometer southeast of Catbalogan pier, outcrop white, chalky marl with small intercalated layers of limestone. Outcrop characterized by color (white). This is in road cut. Fossiliferous material from intercalated fragmental limestone on beach, overlain and underlain by hard, white marl. As one walks on beach across outcrop, the strike changes from north 65° east, dip 122° northwest, to north 85° east, with variations in dip. South 45° east from first rocky point on beach southeast of Catbalogan, about 80 meters from public washing place, is outcrop of dark fragmental limestone between layers of hard marl. Fault cuts series. Collector, H. G. Schenck, November 5, 1920.

Locality F869.—Catbalogan, orbitoidal (lepidocyclinal) limestone from outcrop on beach at small bridge southeast of rocky point about 1.1 kilometers southeast of Catbalogan. Alternate layers of limestone and marl. This limestone is light-colored in contradistinction to the dark limestone at F868. Doubtful attitude north 50° east, dip 30° northwest. Collector, H. G. Schenck, November 5, 1920.

Locality F870.—A. Wright; old name of town is Paranas. Prominent cliff at southern end of town, immediately south of old church, made up of slightly fossiliferous, bluish marl, containing *Globigerina*, with intercalated, hard layers of same material but lignitic. Strike north 40° east, dip 0° to 10° west. Normal fault: no attitude. Hard layers of more indurated phase of marl stand out definitely.

B. At northern side of cliff, stratigraphically unconformably above A and 1 to 2 meters below surface of ground occur vertebrate remains in clay soil. Bones (some human) associated with Recent shells which are stratified and in one place cross-bedded. Bones scattered for a distance of about 5 meters horizontally. Probably a raised beach or old stream deposit, Recent in age. It is not probable that this is an old cemetery, since there is none here now; natives know of no old graveyard, and an old well is 10 meters from locality. Collector, H. G. Schenck, November 15, 1920.

Locality F871.—Coralline Malumbang (Pliocene) limestone at elevation 390 (?) feet (about 130 meters) on Wright-Taft trail, about 7 kilometers in easterly direction from Bagakay and upstream from Marabgas on Malinao River. Small stream at base of 10-meter cliff flowing here north 60° east. Collector, H. G. Schenck, November 19, 1920.

Locality F872.—Fossiliferous Malumbang (Pliocene) limestone on left bank of Malinao River about 0.5 kilometer downstream from place where Wright-Taft trail first touches this river. Steep limestone hills on each side of stream, probably 200 meters high. Locality from which specimens taken is 15 meters above water and about 5 kilometers upstream from landing called Marabgas, municipality of Taft. Collectors, Moody and Schenck, November 19, 1920.

Locality F873.—About 0.5 kilometer northeast from landing at sitio of Otoc, on Calbiga River, 3 kilometers upstream from Calbiga. Outcrop

lignitic and fossiliferous, bluish marl, containing *Globigerina* and resembling material at Wright. Elevation about 80 meters. Dips slightly to southwest, but attitude not definite. Strike may be north 20° east. Creek flows over outcrop to river; downstream marl overlaid by fine-grained buff sandstone (thin layer) occurs. Coal seam at this locality 1 to 5 centimeters thick. Same material exposed along river from Calbiga to Otoc. Collector, H. G. Schenck, December 6, 1920.

Locality F874.—Malinao (Tubig) River near Taft. Fossiliferous and lignitic buff sandstone with clay at same exposure. Collector, G. B. Moody, November, 1920.

Locality F875.—Basey, sitio of Hilabá, Samar, south and east of Tacloban, Leyte. Outcrop of foraminiferal limestone; vertical exposure about 20 meters; shore runs east and west at locality. Prominent cliff undercut by wave action. Collector, H. G. Schenck, December 1, 1920.

Locality F876.—Municipality of Villareal (?), Gologdog Point, about 1 kilometer southwest of Talalora at northern entrance to San Juanico Strait, across from Daram Island. Outcrop of alternating beds of indurated sandstone and fine-grained, calcareous conglomerate containing Foraminifera, striking north 5° west, dip 72° to 90° southwest. Collector, H. G. Schenck, December 2, 1920.

Locality F877.—Municipal district of Matuguinao, about 2 kilometers southeast of barrio at spring. Foraminiferal limestone apparently disturbed by minor faulting. Stream at locality flows south 10° west. Collector, H. G. Schenck, November 10, 1920.

Locality F878.—Catbalogan, Maolong Point, north of town at rock quarry, about 0.5 kilometer northwest of main road and about 2.8 kilometers north of Catbalogan. Limestone breccia (coarse-grained limestone conglomerate) and impure soft limestone (F. N.) both containing Foraminifera. Beds are evidently reworked material, strike northwest and dip to northeast. At top of hill is pure limestone, also containing Foraminifera. Collector, H. G. Schenck, November 1, 1920.

Locality F879.—Anas Point, about 2 kilometers north of Catbalogan and north 60° west from flagpole on pier. Calcareous beds striking northwest disturbed by faulting. Foraminiferal limestone interbedded with a softer, shalelike (marl?) formation. Collector, H. G. Schenck, November 4, 1920.

BIBLIOGRAPHY OF GEOLOGY OF SAMAR

1873. JAGOR, FEDOR. Reisen in den Philippinen. Berlin, Weidmannsche Buchhandlung 16 (1873) 381 pp. English and Spanish translations incomplete.

1876. CENTENO Y GARCIA, JOSÉ. Memoria geológico-minera de las Islas Filipinas. Bol. de la Com. del Mapa geológico de España 3 (1876) 216.

1901. BECKER, GEORGE F. Report on the Geology of the Philippine Islands. Annual Report U. S. Geol. Survey 21 [3] (1901) 493–644.

1904. SADERRA MASÓ, MIGUEL. Volcanoes and seismic centers of the Philippines. Census of the Philippine Islands 3 (1904) 40–41.

1909. ADAMS, GEORGE I. Geologic reconnaissance of the Island of Leyte, etc. Philip. Journ. Sci. § A 4 (1909) 339–356.

Report of the Philippine Commission, Appendix; Mineral Resources, etc. Washington, Government Printing Office.

1913. SADERRA MASÓ, MIGUEL, and SMITH, WARREN D. The relation of seismic disturbances in the Philippines to the geologic structure. Philip. Journ. Sci. § A **8** (1913) 199–232.

1916. PRATT, WALLACE E. Philippine Lakes. Philip. Journ. Sci. § A **11** (1916) 236.

1918. DAVIS, W. M. Fringing reefs of the Philippines. Proc. Nat. Acad. Sci. 4 (1918) 199.

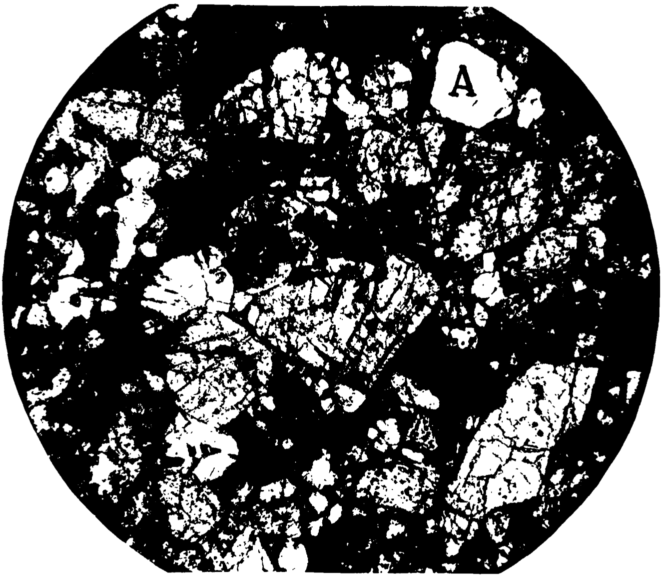
1920. Census of the Philippine Islands. Manila, Bureau of Printing **1** (1920).

ILLUSTRATIONS

Fig. 1. Coast near Catbalogan, Samar; locality F868.

Fig. 2. Dipping marl beds south of Catbalogan, Samar; locality F868.

PLATE 1



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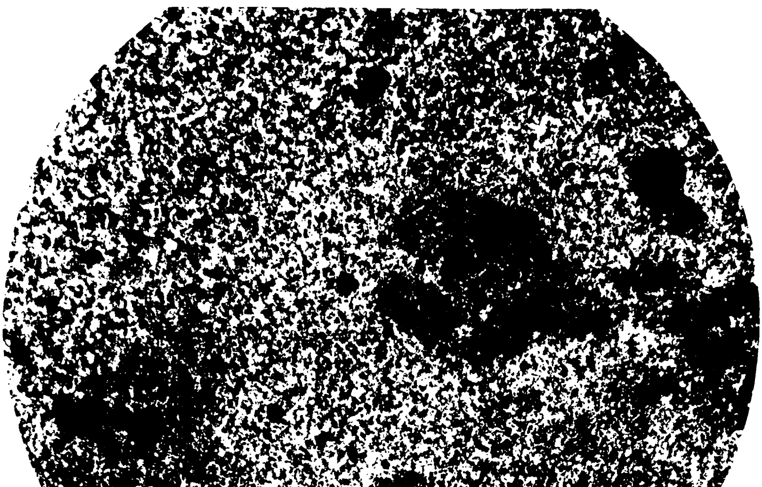

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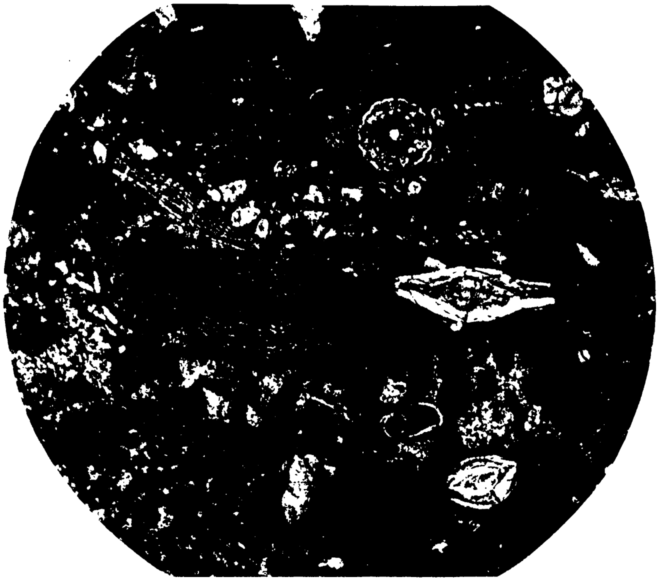
PLATE 2. ROCKS FROM SAMAR.



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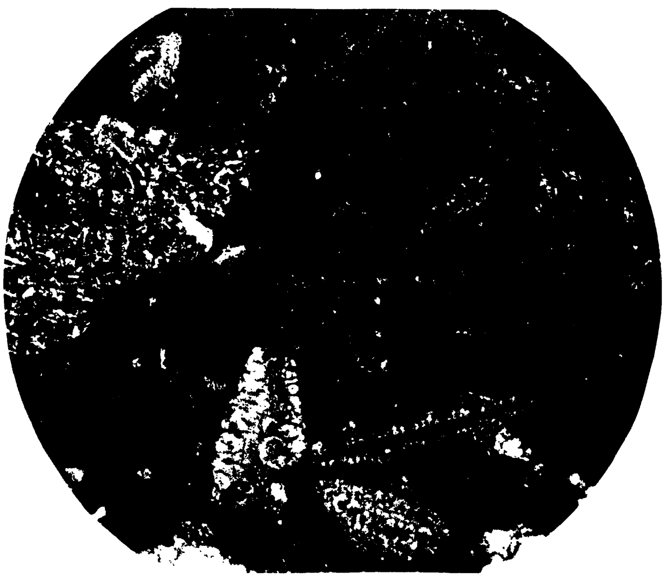

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PLATE 3. FORAMINIFERAL ROCKS FROM SAMAR.

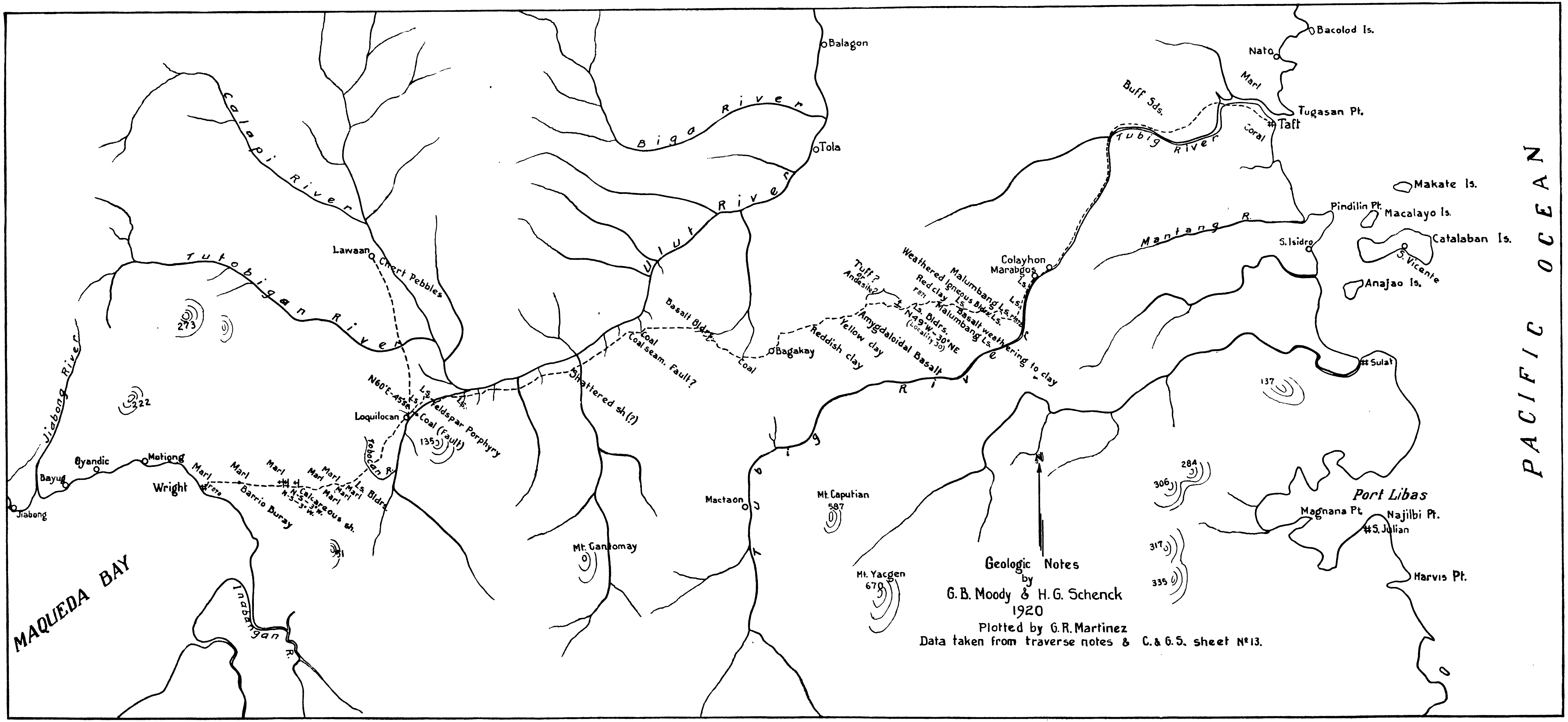

PLATE 4. TRAIL FROM WRIGHT TO TAFT, SAMAR.

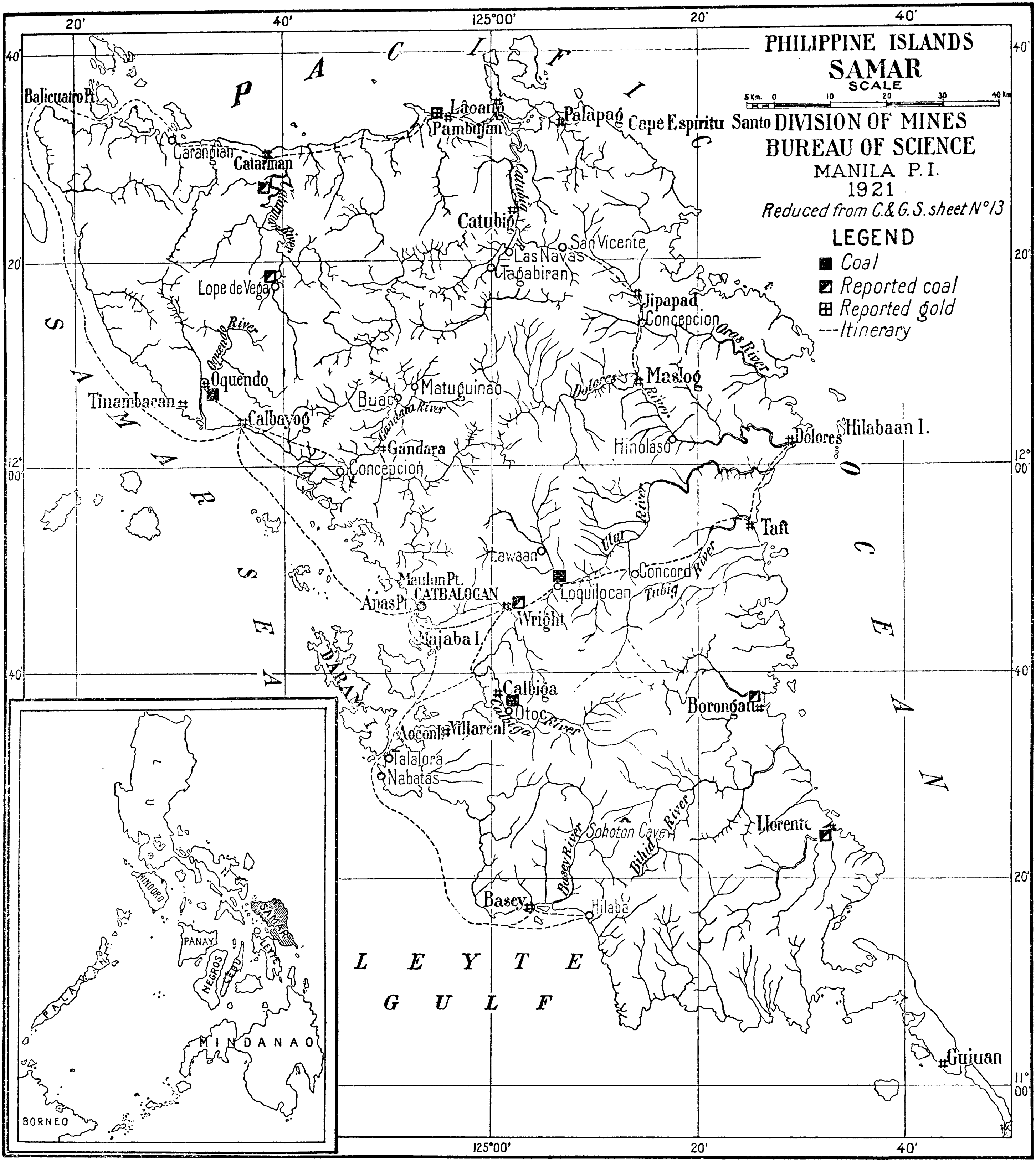

PLATE 5. SAMAR, PHILIPPINE ISLANDS.

CERCOPIDES NOUVEAUX DES PHILIPPINES

Par V. LALLEMAND

Uecle, Bruxelles

APHROPHORINÆ

Clastoptera bakeri sp. nov.

Noire, sur la partie frontale du vertex de chaque côté cinq lignes blanc-jaunâtre séparées par une ligne noire médiane, à la partie inférieure du front de chaque côté une tache blanc jaunâtre; extrémité et bords du clypeus, base du rostre, hanches antérieures, mésosternum, hanches postérieures, articulations des cuisses et des tibias antérieurs et médians, une tache sur les tibias médians et deux taches à la base des épines des tibias postérieurs et les tarses postérieurs sont ocre-jaune, les élytres sont noires; en arrière de l'extrémité du clavus elles sont brunes, plus ou moins ombrées et lignées de noir et légèrement translucides; les yeux sont gris, toute la surface supérieure de l'insecte est densement ponctuée recouverte d'un fin duvet argenté peu dense; sur le pronotum se trouve une carêne longitudinale très marquée allant du bord antérieur au postérieur.

Longueur totale, 3 millimètres.

LUZON, Laguna Province, Mount Maquiling (*Baker*).

Le type se trouve dans ma collection.

Je dédie cette espèce à M. le Professeur C. F. Baker de Los Baños, le distingué hemiptérologiste.

Clovia lineolata sp. nov.

L'insecte est jaune, ligné de noir; sur le front se trouvent cinq lignes noires transversales (la cinquième est brisée en son milieu) ; le bord de la tête, trois bandes transversales sur le vertex et quatre sur le pronotum (les bords antérieurs et postérieurs et deux médianes) sont noirs. Les lignes noires du front constituent le commencement d'une bande qui englobe l'œil, passe sur le prothorax, borde légèrement le pronotum et se continue sur l'élytre en tachant le mesothorax (tache triangulaire). Sur l'élytre existent deux larges bandes longitudinales noire, une l'externe, dont j'ai parlé antérieurement, longe le bord externe jusqu'au milieu de sa longueur d'où elle se dirige vers

l'extrémité en pointe de l'élytre, vers la fin du tiers antérieur, sur cette ligne se trouve un petit tiret jaune. Dans la seconde moitié de l'élytre, dans la partie comprise entre la bande et le bord externe existe une tache hyaline traversée par une bande brune. La second bande s'étend du clavus jusqu'au bord apical prés de l'extrémité de la première; tout le bord interne est longé par une fine bande noire, au niveau de la pointe du clavus, elle se bifurque et englobe une cellule jaune puis se continue jusqu'à l'extrémité en pointe de l'élytre. La première bande est réunie à la seconde par une ligne noire au niveau de la nervure transversale apicale et la deuxième à la bordure noire interne au niveau de la pointe du clavus. Une courte bande noire occupe le côté du mésothorax. La partie supérieure de l'abdomen est estompée de noir; à sa partie inférieure les segments sont bordés latéralement de noirâtre, le dernier segment est bordé en arrière de noir. Chez le mâle le bord interne des sternites et la tarrière sont noirs. Toute la surface supérieure est densement et finement ponctuée et couverte d'une fine villosité jaunâtre, la tête et le pronotum sont aplatis et sur le même plan. L'écusson est plus long que large, les élytres sont terminés en pointe légèrement arrondie. Le front assez aplati, peu convexe, montre à sa partie supérieure cinq à six stries transversales.

Longueur, 8 millimètres.

LUZON, Laguna Province, Los Baños (*Baker*).

Le type se trouve dans ma collection.

Flosshilda translucida sp. nov.

L'insecte est presque entièrement jaune, le vertex et le pronotum, sur son disque, sont légèrement estompés de brun et les épines des tarses sont noires; les élytres sont translucides sauf dans le tiers antéro-interne. Les ocelles sont très proches l'un de l'autre séparés par une fine carêne, la tête est plus courte et un peu plus étroite que le pronotum, le front est lisse et convexe. Le bord antérieur de la tête est en angle obtus; sur l'écusson se voit une grande fossette médiane longitudinale et à sa base deux autres petites fossettes.

Longueur, 6 millimètres.

LUZON, Laguna Province, Los Baños (*Baker*).

Le type se trouve dans ma collection.

Flosshilda furcata sp. nov.

La tête est noire, sauf une tache de chaque côté entre les yeux et la partie frontale du vertex et une troisième entre les ocelles

qui sont de même couleur blanc-jaunâtre; pronotum noir, écusson noir également sauf sa base et sa pointe qui sont blanc-jaunâtres. Les deux tiers antérieurs des élytres sont noirs et le tiers postérieur hyalin, sur les deux tiers antérieurs le bord interne dans sa partie longeant le pronotum et le bord externe dans la moitié antérieure sont jaunâtres, sur la partie hyaline trois bandes noires partent du milieu de l'élytre et du bord postérieur de la partie noire non translucide, la première, droite, aboutit au bord interne en arrière de la pointe du clavus, la deuxième, courbe, aboutit au bord postérieur et le suit quelque peu, la troisième, courbe également, aboutit à l'extrémité du bord externe. Le rostre, le mésothorax, les tibias et les tarses médians et postérieurs sont jaunâtres, les cuisses postérieurs sont jaunâtres avec des taches brunes; les segments abdominaux sont noirs bordés de jaune. La surface supérieure de l'insecte est densement et finement ponctuée et recouverte d'une fine et dense villosité blanc-jaunâtre. Les ocelles sont très proches l'un de l'autre séparés par une fine carêne longitudinale; sur le pronotum est un sillon longitudinal plus marqué dans la partie postérieure.

Longueur, 5 millimètres.

LUZON, Laguna Province, Mount Maquiling (*Baker*).

Le type se trouve dans ma collection.

Flosshilda crassipes var. striata var. nov.

Diffère de l'espèce par les caractères suivants: L'écusson est jaune-rougeâtre avec deux taches triangulaires à la base et une ligne longitudinale médiane noires; sur les élytres se trouve une seconde tache triangulaire hyaline à la fin du tiers antérieur du bord externe et sur le clavus une ligne médiane transversale allant d'un bord à l'autre et en arrière de celle-ci deux taches transversales une à chacun des bords et une ligne longitudinale un peu courbe suivant la nervure, jaune-rougeâtre; sur certains exemplaires moins bien marquées les deux taches postérieures peuvent manquer; la partie postérieure des élytres est plus ou moins translucide, et le dégré de translucidité varie d'un insecte à l'autre; à la partie postérieure de la suture clavo-coriale et chevauchant sur le clavus et le corium se trouve une tache plus claire, plus translucide que la partie des élytres qui suit.

Longueur, 4 mm. 5.

LUZON, Laguna Province, Mount Maquiling (*Baker*).

Le type se trouve dans ma collection.

Poophilus elongatus sp. nov.

L'insecte est brun; le front est un peu plus foncé, les ailes sont morderées avec une trés légère teinte rougeâtre à leur extrémité, les tarses et les épines sont noires. La partie supérieure de la tête est à peu près deux fois aussi large que longue en son milieu, elle est aplatie. Les ocelles sont légèrement plus éloignés l'un de l'autre que des yeux, elle est traversée par un sillon longitudinal qui se prolonge sur le pronotum, au milieu de celui-ci le sillon cesse et est continué par une fine carêne. Le pronotum est bombé et déclive antérieurement, plus large que long, son bord postérieur est concave, sa surface est densement et finement ponctuée. L'écusson est plan, triangulaire, un peu plus long que large. Les élytres sont trois fois aussi longues que larges, elles se terminent en pointe plus ou moins arrondie. Le bord interne est droit jusqu'à la pointe du clavus. Le rostre s'étend jusque entre les hanches médianes. Les tibias postérieurs ont deux fortes épines, toute la surface du corps et des élytres est recouverte d'une fine et dense villosité jaunâtre.

Longueur du corps, 17 millimètres; élytres, longueur, 14; largeur, 4 mm. 5.

LUZON, Manila.

Le type se trouve dans ma collection.

CERCOPINÆ

Poeciloterpa nigrilimbata Stål var. **unicolor** var. nov.

Sauf les extrémités des tarses et des épines qui sont noires et les yeux quelque peu ombrés de noir, l'insecte est entièrement rouge brique; le mésothorax est un peu plus clair tirant légèrement sur le jaune.

Longueur, 6 millimètres.

LUZON, Laguna Province, Los Baños (*Baker*).

Le type se trouve dans ma collection.

Poeciloptera nigrilumbata Stål var. **minuta** var. nov.

Cette variété est comme l'espèce, rouge brique, les tarses et les extrémités des épines sont noirs, à l'extrémité du clavus se trouve une petite tache brune et un peu plus en arrière sur le corium existe une bande brune transversale allant d'un bord à l'autre et brisée en son milieu.

Cette variété diffère surtout de l'espèce par sa taille menue.

Longeur, 3 mm. 5.

LUZON, Laguna Province, Mount Maquiling (*Baker*).

Le type se trouve dans ma collection.

Trichoscarta luteomaculata sp. nov.

Tête, pronotum et écusson noir-verdâtre, à reflets métalliques; les yeux sont gris tachés de brun; sur la partie médiane du front se trouve une tache jaune. Elytres brun-acajou, sur le clavus se montre une bande jaune le long de son bord interne et partant de la base, au niveau de la partie retrécie de l'écusson, elle se rétrécit et se dirige en dedans et en arrière jusque la suture clavo-coriale; sur le corium existent trois petites taches et une bande oranges, la première près du bord externe à l'extrémité du tiers antérieur, la deuxiéme près de la suture clavo-coriale non loin de l'extrémité de la bande jaune du clavus, la troisième au même niveau sur le radius à sa bifurcation, la bande se trouve devant la partie réticulée. Le thorax et l'abdomen sont noirs. Les pattes sont brunes, l'articulation des cuisses aux hanches postérieures est jaunâtre, les tarses postérieurs sont jaune-brun, le front est bombé, vu de côté, il montre un angle obtus, tandis que vu de face il présente deux protubérances émoussées, courtes et coniques, séparées par un sillon longitudinal, le rostre est long, il atteint les hanches postérieures. Le pronotum transversalement ponctué, porte une carêne longitudinale, son bord postérieur est concave et arrondi. L'écusson est plus long que large à sa base; il est prolongé en une longue pointe, transversalement striée. Les élytres sont recouvertes d'une villosité assez longue et brillante. Le mésothorax ne porte pas de protubérance. Les élytres sont deux fois et demi aussi longues que larges; le cubitus et le radius sont réunis sur environ les deux cinquiemes antérieurs de l'élytre.

Longueur, 16 millimètres.

PALAWAN (*Noualhier*).

Le type se trouve dans la collection du Musée de Paris.

Serapita philippinensis sp. nov.

Vertex, pronotum brun-chocolat avec un léger reflet violet; écusson violet foncé à extrémité jaune; les élytres noirâtres deviennent brun foncé à leur partie apicale, leur bord interne, jusqu'à l'extrémité de l'écusson, est étroitement jaune-brun, trois taches de même couleur se trouvent sur le corium, une sur le rameau commun du médian et du cubitus réunis, à la fin d'un quatrieme antérieur, et les deux autres transversales en avant de la partie reticulée, une près du bord externe et l'autre sur le cubitus près de l'extrémité du clavus. Les ailes sont enfumées. Le front est brun-clair; les yeux sont gris clair; le thorax et l'abdomen sont noirâtres; le rostre et les pattes sont d'un brun

plus ou moins jaunâtre, les tarses sont plus nettement jaunâtres. Le pronotum rugueux, à rides transversales, porte une carêne médiane très nette et son bord postérieur est concave et arrondi; l'écusson est grand, transversalement strié et en son milieu creusé en une large fossette; sur le tiers antérieur des élytres, le médian et le cubitus sont réunis en un tronc commun. Le bord postérieur [1] du mesothorax est foliacé et la protubérance du mésothorax n'est pas conique mais un peu aplatie.

Longueur, 1 mm. 5.

LUZON, Laguna Province, Los Baños (*Baker*).

Le type se trouve dans la collection de Baker et dans la mienne.

Serapita montis sp. nov.

Tête jaunâtre, pronotum, de même couleur, brunâtre sur la partie postérieure de son disque, une tache brune rectangulaire derrière le bord antérieur. Les élytres brun-jaunâtre, sont jaunes à leur base et au bord interne le long du pronotum, elles ont deux taches jaunes au bord externe, une à la fin du tiers antérieur et l'autre à la fin du second tiers. Tête, thorax, pattes et abdomen, jaunâtres; ailes d'un brun-jaunâtre clair. Ocelles á égale distance l'un de l'autre et des yeux. Le pronotum fort convexe, est densement ponctuée à carêne médiane très marquée, ses angles scapulaires sont un peu dilatés comme chez *Leptataspis angulosa* Stål, son bord postérieur est concave. L'écusson grand, fortement et transversalement strié, montre à sa partie médiane une assez large fossette. Sur les élytres, le médian et le cubitus sont soudés sur le tiers antérieur. Les protubérances du mésothorax sont transversales, très légèrement aplaties d'avant en arrière, le bord postérieur est foliacé.

Longueur, 14 millimètres.

LUZON, Mount Banahao (*Baker*).

Le type se trouve dans ma collection.

[1] Dans mon travail sur les Cercopides paru dans les Genera Insectorum Fasc. 143, j'ai écrit plusieurs fois par erreur "bord *antérieur* du mésothorax," c'est *postérieur* qu'il faut lire.

IDENTIFICATION OF BACTERIA PATHOGENIC TO PLANTS PREVIOUSLY REPORTED FROM THE PHILIPPPINE ISLANDS

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The study of phytobacteriology has not been pursued to any extent as yet in the Philippine Islands. The bacterial diseases that have been reported have been identified, with a few exceptions, mainly through symptoms, the cultural and morphological studies having been omitted.

The present paper is the first of a series in which all known bacterial organisms, pathogenic to plants found in the Philippine Islands, will be briefly described. In this paper *Bacterium solanacearum* E. F. Sm., *Pseudomonas phaseoli* E. F. Sm., *Bacterium malvacearum* E. F. Sm., and *Bacillus nelliae* sp. nov. are reported upon.

REVIEW OF LITERATURE

A bacterial wilt of solanaceous plants, especially of tobacco (*Nicotiana tabacum* Linn.) has been observed to be very destructive locally. Reinking(5) examined tissues of wilted tobacco, eggplant, and tomato plants and found the vascular elements entirely clogged with bacteria which, in advanced stages, frequently invaded the parenchymatous tissue. From the abovementioned observations the disease was reported as solanaceous wilt and was said to be caused by *Bacillus solanacearum* E. F. Sm. The description of the symptoms is similar to that given by Smith(7) and by Garner, Wolf, and Moss.(3)

Bean blight, common in the United States, caused by *Pseudomonas phaseoli* E. F. Sm., was also reported by Reinking.(5) The disease was described as follows:

> This well-known disease is * * * destructive on *Phaseolus vulgaris* Linn. and on *Phaseolus lunatus* Linn. Leaves, stems, and pods are attacked. Characteristic, irregular brownish spots with water-soaked edges are produced on the leaves. * * * The organism attacks pods, forming a characteristic watery spot, and also works down into the seed, thus infecting the latter.

On microscopic examination Reinking found the organisms to be abundant in leaf veins and exuding from those elements in mounted sections. No studies were made with pure cultures of the organism.

The above description of symptoms is very similar to that of Burkholder.(1)

Reinking(5) reported the presence of angular leaf spot of cotton caused by *Bacterium malvacearum* E. F. Sm. He says of this disease:

> The disease is present on leaf, stem, and fruit. On the leaf the characteristic spots are from 1 to 4 millimeters in diameter; they are angular with brownish centers bordered with light brown to yellow. Young spots are similar and have a water-soaked appearance. * * * The disease may be evident on the tender stalks in the form of blackened cankerous patches. On the bolls, at first, minute water-soaked spots are produced, which later may run together, producing sunken brownish or reddish brown blotches.

Furthermore, Reinking states that "The causal organism is a bacterium that produces a yellow pigment in pure culture." No proof is given to show that the organism forming the yellow pigment is the pathogenic or the saprophytic one commonly associated with the disease.

The descriptions of the symptoms of the disease compare favorably with those of Rolfs,(6) McCall,(4) and Faulwetter.(2) While the descriptions of symptoms are valuable they do not furnish proof of the identity of the causal organism. Because of the accuracy of the preceding descriptions they will suffice for the present paper. The physiological and morphological studies carried on with the various organisms are here presented briefly. In each case inoculations under controlled conditions were carried out to prove the pathogenicity of the organisms.

BACTERIUM (BACILLUS) SOLANACEARUM E. F. Smith.

The organism was isolated from wilted tobacco, eggplant, and tomato plants. Isolations were made by crushing the material, after treatment for one minute in corrosive sublimate, 1 to 1,000, in sterile water, and plating directly in nutrient agar.

The organism stains readily with the common aniline dyes and shows no irregularity in taking the stain. The cells measure from 0.8 to 1.2 μ in length.

According to Smith(7, 10) the cells measure 0.6 to 1.0 μ in length with several peritrichous flagella.

The artificial media used were titrated to + 10 Fuller's scale.

Nutrient agar slant.—After twenty-four hours, growth was abundant, filiform, convex, dull, smooth, opaquè, dirty white, without odor, and slimy. After ten days the growth became brownish, with a slight brownish coloring of the agar. According to Smith(7, 10) the growth was white, smooth, moist, glistening, becoming yellowish brown to brown and the agar was stained brown.

Nutrient agar colonies.—After twenty-four hours, rapid growth had taken place at 26° to 28° C., with colonies round, smooth, convex, entire-edged, and finely granular internal structure.

Potato slant.—After twenty-four hours, growth was moderate, filiform, slightly convex, dull, smooth, brownish, no odor, and slimy. After a week, the growth became a deep brown. According to Smith(7, 10) the growth was dirty white becoming brownish to smoke-black.

Sugar media.—Neither gas nor acid was formed in saccharose, dextrose, lactose, or mannite. Smith(10) reports that acid and gas are not produced in common sugar media.

Nutrient broth.—After twenty-four hours, growth was abundant, surface growth was more or less flocculent, becoming evenly distributed throughout the medium on agitation. Clouding was moderate, without odor. A slight sediment was formed and an alkaline reaction was obtained. According to Smith(7, 10) zoogloea developed in the upper layer, giving the medium uniform turbidity on agitation. An alkaline reaction developed.

PSEUDOMONAS PHASEOLI E. F. Smith.

The organism was isolated from diseased bean leaves (*Phaseolus vulgaris* Linn.) by crushing the material in sterile water and plating directly in potato agar.

The bacterial cells stain readily with the common aniline dyes and appear as short rods with rounded ends. Smith(8) states that "*Bacillus phaseoli* E. F. S. is a short rod with rounded ends, * * * motile in early stages of growth."

All artificial media were titrated to + 10 Fuller's scale.

Nutrient agar slant.—After twenty-four hours, growth was moderate, entire-edged, convex, glistening, smooth, opaque, yellow (chrome), with an odor of slight putrefaction, and of slimy consistency.

Potato agar colonies.—After three days, growth was moderate and colonies were round, smooth, convex, edge entire, internal

structure finely granular. The colonies were yellow with hyaline center. The starch was reduced by the action of the bacteria. Smith (9) states that copious and prolonged growth occurred, covering the potato plug and developing in the water, and within a few weeks the starch was hydrolized.

Nutrient broth.—After twenty-four hours, there was a slight, tough surface growth, which sank on agitation. There was slight, even cloudiness throughout the medium.

Lactose broth.—There was slight flocculent precipitate with no acid and no gas.

Dextrose broth.—There was considerable surface growth. No gas was produced; the reaction was strongly acid.

Saccharose broth.—There was a moderate surface film not breaking up on agitation. No gas was produced.

Mannite broth.—Flocculent precipitate developed in the medium. There was no gas, and the reaction was slightly acid. Smith (9) states that on agars containing various sugars growth was copious.

Glycerine broth.—There was a flocculent growth and the medium was heavily clouded. No gas was produced, and the reaction was slightly acid.

Nitrate broth.—There was a moderate flocculent growth. Neither gas nor acid was produced, and there was no reduction in four weeks.

Nothing has been published, to my knowledge, giving the complete growth characters of this organism. There have been a few reports where partial culture work has been given. As the descriptive chart of the Society of American Bacteriologists is being followed in this paper to a large extent, the cultural characters in Smith's famous paper of 1901 permit of very little comparison. However, from the symptoms and the checking of a few comparative factors the organisms as well as the diseases seem identical.

BACTERIUM MALVACEARUM E. F. Smith.

The organism was isolated from young, watery lesions on leaves of cotton, by the method given above. The cells stain readily with the common aniline dyes, showing no irregularity in taking the stain.

Nutrient agar colonies.—After twenty-four hours, growth was moderate (26° to 28° C.). The colonies were round, smooth, convex, entire-edged, with internal structure finely granular, with

a diameter of 1 to 3 μ. A pale yellow pigment was produced. According to Rolfs,(6) the amount of growth appeared on different sugar media in the order named; dextrin, mannite, maltose, and dextrose, and a pale yellow pigment was produced on agars.

Nutrient agar slant.—After twenty-four hours, growth was moderate, filiform, raised, glistening, smooth, opaque, pale yellow, odor of putrefaction, and a slightly slimy consistency.

Nutrient broth.—There was a thin surface growth. Culture was moderate and uniformly clouded and no sediment was formed.

Lactose broth.—A light surface growth appeared.

Dextrose broth.—There was moderate surface growth, with no gas, and a strongly acid reaction.

Saccharose broth.—There was a surface growth and a moderate, uniform clouding of the liquid. No gas was formed.

Mannite broth.—No gas was formed, and the reaction was strongly acid.

Glycerine broth.—There was no gas and no acid. Clouding was slight. Rolfs(6) states that growth was poor on glycerine agar.

The description of the organism by Rolfs checks with the organism just described, excepting that no difference in degree of growth was observed on the various sugar media. The nonpathogenic organism producing the bright yellow pigment, mentioned by Rolfs, was frequently encountered in isolations, and it caused considerable trouble as it appeared before the pathogenic pale yellow organism.

BACTERIAL WILT OF PARSLEY

The bacterial wilt of parsley, which has been found to be caused by a new species of bacteria, was for several seasons believed to be caused by *Bacillus solanacearum* E. F. Sm. The vascular bundles, on microscopic examination, appeared to be packed with bacteria, and the whole behavior of the parasitized plants was precisely like that of solanaceous plants parasitized by *Bacillus solanacearum* E. F. Sm. A further substantiation of this diagnosis was that the diseased plants were found on soil which was known to be heavily infested with the solanaceous wilt organism. On making physiological studies, the organism proved to be entirely different from *Bacterium solanacearum* E. F. Sm.

BACILLUS NELLIAE sp. nov.

The organisms are short rods with rounded ends, 0.83 to 2.27 μ by 0.37 to 0.50 μ. They stain readily with all common aniline dyes, and show no irregularities in taking the stain. The thermal death point lies between 53° and 54°. Three to seven peritrichous flagella have been demonstrated. The artificial media were titrated to + 10 Fuller's scale.

Nutrient agar stroke.—After twenty-four hours, growth was moderate, filiform, flat, more or less glistening, contoured, whitish by transmitted and translucent by direct light, without odor, and of a slimy consistency. With age the culture became irregularly raised.

Nutrient agar colonies.—Surface colonies after twenty-four hours were round, slightly concentrically ringed, raised, finely granular in structure, and with an entire edge.

Potato agar slant.—Growth was moderate, spreading, with yellow pigment, flat, smooth, odorless, and of viscid consistency.

Nutrient agar stab.—There was moderate arborescent growth, and considerable surface growth.

Potato-glucose agar stroke.—After twenty-four hours, growth was abundant, filiform, slightly convex, glistening, translucent, becoming opaque, and of a viscid consistency. Gas was formed under the medium forcing the latter up in the tube.

Dextrose broth.—Acid and gas were produced.

Lactose broth.—Gas was produced. The reaction was slightly acid.

Galactose broth.—Gas was formed. A strong acid reaction was obtained.

Saccharose broth.—Gas was formed, and the reaction was strongly acid.

Mannite broth.—Gas and a strongly acid reaction resulted.

Glycerine broth.—Neither gas nor acid was formed. Growth took place in the closed and open arms of fermentation tubes.

Nitrate broth.—There was no reduction; neither gas nor acid was produced.

Toleration of sodium chloride.—Growth occurred at 8 per cent concentration.

Effect of sunlight.—Twenty minutes' exposure reduced but did not inhibit growth.

LITERATURE CITED

1. BURKHOLDER, WALTER H. Bean diseases in New York State in 1916. Abs. Phytopath. 7 (1917) 61.

2. FAULWETTER, R. C. The angular leaf spot of cotton. Bull. S. C. Agr. Exp. Sta. **198** (1919) 1–29.
3. GARNER, W. W.; WOLF, F. A.; and MOSS, E. G. The control of tobacco wilt in the fluecured district. Bull. U. S. Dept. Agr. **562** (1917).
4. McCALL, J. STEWART. Bacterial blight of cotton. Trop. Agr. **34** (1910) 373, 374.
5. REINKING, OTTO A. Philippine economic-plant diseases. Philip. Journ. Sci. § A **13** (1918) 165–274.
6. ROLFS, F. M. Angular leaf spot of cotton. Bull. S. C. Agr. Exp. Sta. **184** (1915) 1–30.
7. SMITH, ERWIN F. A bacterial disease of the tomato, eggplant and Irish potato. Bull. U. S. Dept. Agr. Div. Veg. Physiol. & Path. **12** (1896) 1–26.
8. SMITH, ERWIN F. Description of Bacillus phaseoli sp. nov. with some remarks on related species. Proc. Am. Assoc. Adv. Sci. 46th meeting 1897 (1898) 288–290.
9. SMITH, ERWIN F. The cultural characters of Pseudomonas hyacinthi, Pseudomonas campestris, Pseudomonas phaseoli, and Pseudomonas stewarti—four one-flagellate bacteria parasitic on plants. Bull. U. S. Dept. Agr. Div. Veg. Physiol. & Path. **28** (1901) 153.
10. SMITH, ERWIN F. Bacteria in relation to plant diseases. **3** (1914) 174–206.

SOME RESULTS WITH INTELLIGENCE TESTS IN THE PHILIPPINE ISLANDS

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EIGHT TEXT FIGURES

The present paper consists of three parts. Part one gives the results of the application of the Otis group intelligence scale to 1,000 male and 752 female teachers in Tayabas, Batangas, Laguna, and Rizal Provinces. Part two gives the results of the same scale applied to 166 male and 59 female teachers from all parts of the Philippines, gathered in convention at Baguio. Part three gives the results of the application of the Yerkes point scale to 146 boys and 29 girls, many of them of mixed blood, in the Palawan Provincial School at Cuyo.

PART ONE

The Otis group intelligence scale was devised by Dr. Arthur S. Otis, of Leland Stanford Junior University, and was copyrighted by the World Book Company in 1919. It was one of the first and most satisfactory scales devised for testing subjects in groups. It is very similar in form to the Alpha examination adopted by the United States Army later.[1]

The Otis scale tests chiefly the higher mental processes, such as controlled association, analysis, logical judgment, synthesis, and generalization. Comprehension of language (English), memory, and imagination are, of course, also involved. Incident to the group method, in which the correct response (to be underlined by the subject) to each problem is suggested along with several incorrect responses—which makes possible a rapid scoring of the examination sheets by means of stencils—is the important element of recognition, but what Terman says of recognition in reading probably applies here:

> Recognition is for the most part an associative process. Rapid and accurate association will mean ready recognition of the printed form.[2]

[1] Yoakum and Yerkes, Army Mental Tests. New York (1920) 2.
[2] Terman, The Measurement of Intelligence. New York (1916) 265.

Table 1 outlines the principal mental functions involved in meeting the requirements in each separate test in the scale.

TABLE 1.—*Mental functions involved in Otis scale test.*

Test No.	Requirement.	Principal mental functions involved.
1	Following directions	Comprehension of language, reaction according to instructions, inhibition of interfering associations and perseverations.
2	Giving opposites	Controlled association—which lies at the basis of the reasoning process.
3	Arranging disarranged sentences.	Ideation, vocabulary, memory, analysis, logical integrity of the association process.
4	Interpreting proverbs	Generalization, language.
5	Solving arithmetical problems.	Arithmetical reasoning, attention.
6	Discriminating between geometric figures.	Visual discrimination, comparison, attention, comprehension of language.
7	Completing analogies	Logical judgment and analysis.
8	Giving similarities	Controlled association—"Thinking means essentially the association of ideas on the basis of differences and similarities." [a]
9	Completing a narrative	Synthesizing ability—"Intelligence is essentially a combinative activity," [b] memory, association.
10	Memory	Logical or substance memory, immediate memory for ideas, language, "Language growth mirrors the entire mental development . . . it is the *sine qua non* of conceptual thinking," [c] suggestibility.

[a] Terman, The Measurement of Intelligence. New York (1916) 202.
[b] Whipple, Manual of Mental and Physical Tests. Baltimore (1914) 649.
[c] Terman, op. cit. 265.

Table 2 shows the total number of scores made by the provincial teachers, and the number of men and women making each score. The average score for the men is 77.0 and for the women 70.9.

Fig. 1 shows graphically the data that are recorded in Table 2. The class interval is ten points. The regularity of the curves for the men and the women, and the fairly constant relation between the two, indicate that enough data were obtained to give representative results.

Table 3 gives the average scores made by the teachers in the different provinces, which are all Tagalog.

Prof. H. Otley Beyer, of the University of the Philippines, says the following concerning the Tagalog group of Philippine peoples:

Number, 1,789,049; the second largest Philippine group and the highest in cultural development. *Loc.:* The great majority of the Tagalogs are found in Luzon, where they form the greater part of the population in the following provinces: Tayabas, Batangas, Cavite, Laguna, Rizal, Manila city, Bataan, Bulacan, and Nueva Ecija. Considerable numbers are also

TABLE 2.—*Showing all scores made by the provincial teachers and the number of men and women making them.*

[B, Batangas; L, Laguna; R, Rizal; T, Tayabas.]

Score.	Number.		Score.	Number.		Score.	Number.	
	Male.	Female.		Male.	Female.		Male.	Female.
3	B 1		61	14	14	108	7	6
10	L 1		62	14	20	109	6	5
13		T 1	63	11	9	110	7	2
15	L 1	R 1	64	16	13	111	4	2
16	B 1		65	12	11	112	3	1
18	L 1	T 1	66	18	10	113	4	2
20		R,T 2	67	16	13	114	6	3
21	2	4	68	17	18	115	5	3
22	2	1	69	12	11	116	8	
23	1	2	70	14	10	117	6	2
24	1	2	71	21	16	118	1	5
25	1		72	16	10	119	7	2
26	3	1	73	16	2	120	2	
27	3	2	74	18	23	121	3	1
28	1	3	75	26	8	122	9	3
29	2	4	76	14	7	123	2	1
30	3	4	77	15	11	124	2	2
31	3	8	78	16	8	125	2	2
32	2	4	79	10	12	126	4	
33	4	4	80	18	11	127	2	1
34	7	4	81	15	12	128	3	
35	7	2	82	18	14	129		2
36	3	7	83	9	10	130	1	5
37	3	6	84	12	11	131	1	1
38	7	3	85	15	6	132	2	
39	3	4	86	9	11	133	1	1
40	5	5	87	15	12	134	3	1
41	5	5	88	12	2	136	2	
42	14	6	89	15	8	137	5	
43	6	6	90	13	9	138	1	
44	11	7	91	8	5	139	2	
45	3	8	92	8	7	140	1	
46	7	17	93	10	6	141	1	
47	8	9	94	13	5	142	2	
48	10	8	95	16	9	144		L 1
49	9	7	96	8	8	147	T,B 2	
50	13	12	97	15	4	149	T 1	L 1
51	16	10	98	9	5	150	T 1	
52	7	8	99	9	11	151		R 1
53	7	11	100	9	6	153	R 1	T 1
54	9	13	101	15	9	154		L 1
55	11	10	102	7	4	156	L 1	
56	14	7	103	2	3	161	L 1	
57	12	10	104	6	3	163		L 1
58	13	14	105	8	6	167	R 1	
59	11	11	106	7	4	171		L 1
60	16	13	107	7	3	Total	1,000	752

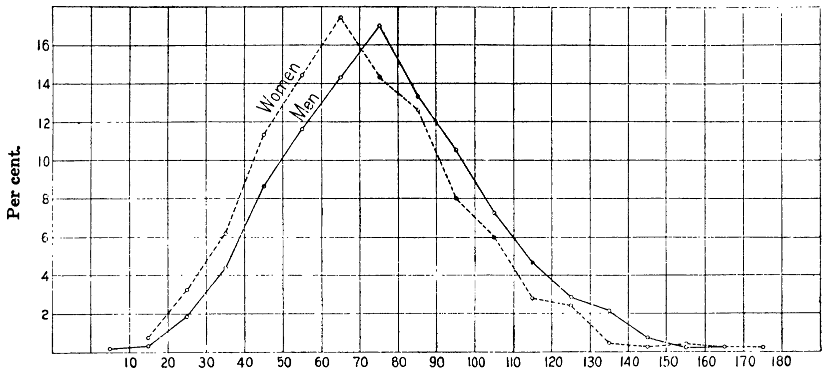

FIG. 1. The percentile distribution of scores for men and women—provincial group.

TABLE 3.—*Showing the average scores made by teachers in the several Tagalog provinces.*

Province.	Number.	1	2	3	4	5	6	7	8	9	10	Total.
MEN.												
Rizal	152	8.4	9.7	10.8	3.7	9.9	6.4	7.4	7.3	8.2	11.0	82.8
Tayabas	366	7.9	11.4	8.4	4.7	8.7	6.0	5.7	6.1	8.8	9.5	77.2
Laguna	257	7.6	9.6	8.2	4.0	9.3	5.9	7.2	6.6	6.8	10.0	75.2
Batangas	225	8.1	9.1	8.3	3.3	10.3	6.3	7.1	6.8	6.4	9.4	75.1
Total	1,000	7.9	10.2	8.7	4.0	9.4	6.1	6.7	6.6	7.6	9.8	77.0
WOMEN.												
Tayabas	176	7.4	11.3	9.0	4.3	7.3	5.5	5.1	5.3	8.6	9.4	73.2
Laguna	209	7.4	9.4	8.0	3.5	7.9	5.6	6.0	5.9	7.7	9.9	71.3
Rizal	203	7.5	8.0	8.7	2.3	8.4	5.6	6.7	7.1	6.7	9.3	70.3
Batangas	164	7.5	8.4	6.9	2.6	8.4	5.6	6.5	6.6	5.8	10.0	68.3
Total	752	7.5	9.3	8.2	3.2	8.0	5.6	6.1	6.2	7.2	9.6	70.9

found in northern Camarines, Tarlac, and southern Zambales. In addition to Luzon, the island of Marinduque is wholly Tagalog, while Masbate is partly so, and the coastal region of the northern two-thirds of Mindoro. A few individuals are to be found in practically every province of the Islands, while numbers have emigrated to the United States, Hawaii, Japan, the China Coast, and other foreign lands. *Char.:* Christian; and possessing the general Spanish-Filipino civilization of the lowland people. In a majority of the Tagalog provinces the predominating physical type is a Malay blend with the short and tall Mongol elements exceedingly prominent. The chief exceptions are the provinces of Batangas, Cavite, and a few minor localities, where the Indonesian element is most in evidence. . . The people of the coastal regions are much mixed and tall types predominate, while those of the interior are more uniform and short types are common.[8]

[8] Beyer, H. O., Population of the Philippine Islands in 1916. Manila, Philippine Education Co. (1917) 70–71.

It should be understood that Beyer recognizes the following racial types in the Philippine Islands:

Three dwarf types.—(1) The aboriginal Negrito—short, slender, very dark, frizzly-haired, body hairless, face Negroid; (2) a very old Australoid Ainu mixture—short, stocky, light, hairy, early gray, face Caucasian; and (3) the Proto-Malay—short, stocky, dark, body hairless, face Mongoloid, nose short and immobile, eyes prominent, third lid, wide apart.

Three tall types.—(1) The Malay—slender, brown, face flat and oval, probably an early and progressive Chinese-Indonesian mixture; (2) the Indonesians, which are divided into three subtypes—(A) tall, slender, light, Caucasian features; (B) tall, heavier, dark, Semitic features; and (C) tall, heavy, very dark, Negroid features; and (3) the Papuan—true Negro type.[4]

Table 3 shows some exceedingly interesting provincial differences. There is a difference of twelve points in the average total score for the men and women of Rizal, whereas the sex difference in the other provinces is much less.

There exist some striking differences in physical type between the men and the women of the same groups in various localities in the Philippines. Among the Ifugaos, for example, the men belong in general to the Malay blend type, while the women belong clearly to the Proto-Malay type. It seems, in other words, that the women represent in physical type the older mountain people who were conquered by the later Malay invaders, who imposed upon them their general culture, and their physical type upon their sons, but who could produce apparently no change in the appearance of the women and their daughters in some sixteen centuries.

The same thing is probably true in Rizal. At one time there existed a great Chinese settlement in Mariquina Valley. Now, possibly not only physically, but mentally, the women represent the older, more primitive type of the province, while the men represent the more recent and the more intelligent Chinese element.

Tayabas ranks most consistently high for both men and women. Tayabas was but lightly populated when the Spaniards came to the Islands in the sixteenth century. Many of the present inhabitants and their descendants emigrated within the last one hundred years from Laguna, Bulacan, and Nueva Ecija. The people of Tayabas represent, therefore, a progressive and venturesome people.

[4] See Beyer's article in The Census of the Philippine Islands for 1918 2 (1921) 907–957.

The prevalent type in Laguna is the tall, light Malay blend. There has been considerable intermixture with Chinese, and some Spanish intermixture.

The Batangas teachers scored lowest. The Batangas type is a Malay blend, but with the Indonesian B element very prominent. There has been less intermixture with foreign blood than in the other provinces.

Table 4 gives the averages for these teachers taken in groups of educational attainment. The figures are significant.

TABLE 4.—*Showing average scores of the provincial teachers taken in groups of educational attainment.*

[Q. C. D., Quartile coefficient of dispersion.]

Group.	Men.			Women.		
	Number.	Score.	Q. C. D.	Number.	Score.	Q. C. D.
Below seventh grade	50	56.9	0.28	53	53.4	0.30
Intermediate graduates	509	70.5	0.16	498	69.1	0.25
First-year high school and normal school	196	73.5	0.25	125	70.8	0.21
Second-year high school and normal school	83	85.6	0.21	39	85.5	0.19
Third-year high school and normal school	38	93.4	0.13	6	95.0	0.19
Fourth-year and graduate high school	83	103.0	0.16	23	109.3	0.21
Fourth-year and graduate normal school	28	115.6	0.16	88	113.6	0.16
College graduates and undergraduates	13	110.5	0.17			
Total	1,000			752		

It must not be forgotten that the Otis scale is an intelligence scale. It is not a test of knowledge.

Intelligence is the capacity of the mind; and knowledge is the raw material that is put into the mind.[5]

Stern says:

The tests do actually reach and discover the general developmental conditions of intelligence and not mere fragments of knowledge and attainments acquired by chance.[6]

Terman says that school instruction is impotent to neutralize individual differences in native endowment.[7] Yerkes, in a study of the intelligence of university students and of mill operatives, in which he found the former superior, says:

[5] Platt, R. H., Measuring minds, World's Work (Sept. 1920).

[6] Stern, Psychological Methods of Testing Intelligence. Baltimore (1914) 49.

[7] Terman, The Measurement of Intelligence. New York (1916) 116.

It seems extremely improbable that this superiority is in any considerable measure due to higher education.[8]

It would be wrong to affirm that schooling has no influence at all upon the intelligence score, especially in the case of Filipinos who are given the test in the English language; for, although the Filipinos in question speak English and teach in English schools, they are, of course, less familiar with the language than American teachers. However, it will be shown later that this influence must not be overemphasized even in this case. A very considerable difference in average intelligence will be noted between seventh-grade and college graduates (see Table 4). It is much more likely that the teachers of lower educational attainments would have been unable to continue their education in the higher classes successfully. The C, or average grade of intelligence, in this case represented by a score from 52 to 81, "is rarely capable of finishing a high school course." [9]

The large gap between the average score of the teachers who had completed the intermediate school and those who had completed the first-year high-school course—73.5 and 85.6, boys only (teachers in the Bureau of Education rate their "attainment" as one year in advance of the year actually completed)—is probably of great significance in the matter of the high "mortality" in the first-year high-school class in the Philippines. About half of the students fail each year.

The fact that the normal-school graduates rank higher than the high-school graduates may be explained by the fact that, while normal-school graduates are definitely destined for the

TABLE 5.—*Showing equivalent scores in the army tests and the Otis scale.*

Letter rating.		Army test.	Otis scale.
A	Very superior intelligence	135-212	142-230
B	Superior intelligence	105-134	112-141
C+	High average intelligence	75-104	82-111
C	Average intelligence	45-74	52-81
C−	Low average intelligence	25-44	32-51
D	Inferior intelligence	15-24	22-31
D−	Very inferior intelligence	0-14	0-21

[8] Yerkes, Bridges, and Hardwick, Point Scale for Measuring Mental Ability. Baltimore (1915) 93.

[9] Yoakum and Yerkes, Army Mental Tests. New York (1920) 23.

teaching profession, most high-school graduates of high ability go into other and more remunerative employment.

Table 6 is a comparison of the results obtained with the Alpha examination in the United States Army and the Filipino teachers. It is based on the following table of equivalent scores taken from a recent circular of the World Book Company.

TABLE 6.—*Showing intelligence of American soldiers and Filipino teachers.*

Letter rating.	Meaning.	Percentage of American draft quota.[a]	Percentage of Filipino provincial teachers (men).
A	Very superior (approximate)	4-5	1.0
B	Superior	8-10	9.2
C+	High average	15-18	29.9
C	Average	25	42.9
C−	Low average	20	14.3
D	Inferior	15	2.0
D−	Very inferior	----------	0.7

[a] The figures for the United States Army were taken from "Army Mental Tests" which has been quoted several times before.

The Filipino group contains comparatively few men of very superior intelligence, but a higher percentage of high average and average, and a lower percentage of inferior and very inferior. The lower end of the table may be explained by the fact that the Filipino group was a selected one while the United States draft group was not. On the other hand, the smaller percentage of men of very superior ability in the Filipino group may be explained in part by the fact that many English-speaking Filipinos of ability do not enter the Government service in as much as private firms often offer more attractive salaries.

PART TWO

Table 7 shows the results obtained by applying the Otis scale to the 166 male and 59 female teachers from all parts of the Islands gathered in convention at Baguio, the summer capital of the Philippines. The more careful selection is at once apparent. The average for the men is 122.0 and for the women 115.0.

Fig. 2 gives graphically the data recorded in Table 7. Owing to the small number of individuals tested and the consequent irregularity of a curve drawn on smaller class intervals, the class interval in this case was made twenty points.

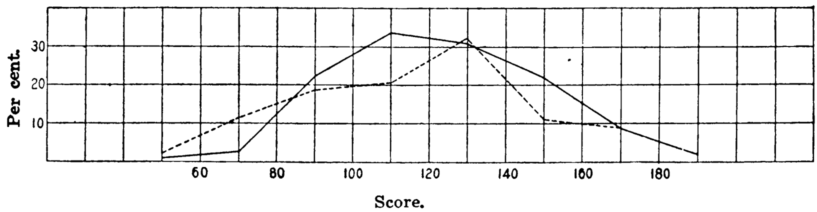

FIG. 2. Percentile distribution of scores for men and women—Baguio group.

TABLE 7.—*Showing all the scores of male and female teachers in the Baguio group.*

Score.	Number.		Score.	Number.		Score.	Number.	
	Male.	Female.		Male.	Female.		Male.	Female.
54	1		106	1		136		4
58		1	107	3		137	2	1
61	1		108	2		138	2	
62		1	109	2		139	2	2
71		1	110	3		140	1	
75	1		111	2	3	141	2	1
77		1	112	4		142	2	1
78	1	2	113	6		143	1	1
79		2	114	4	1	144	2	1
80	1		115	2	1	145	1	
82	1	1	116	5	1	146	2	1
83	1		117	2	3	147	3	
84	1		118	2		148	2	
85	1	2	119	1	2	149	1	
86		3	120	3		150	1	
88		1	121	3		152	2	
90	1	1	122	2	2	153	1	
91		1	123	3		154	2	
92	1		124	3	1	155	1	
93	4		125	6		156	1	
95	1		126	2		157	1	1
96	5	1	127	1	1	158	2	1
97	1		128	4	2	161	1	
99	2	1	129	5	1	162		1
100	1		130	1		163	1	
101	1		131	6	3	164	1	
102	6	1	132	2	2	166	2	
103	2		133	4		171	1	1
104	1		134	2		183	1	
105	2		135	1		189	1	
						Total	166	59

Table 8 gives the averages for the teachers taken in groups of educational attainment. The comparison between this table and Table 4 is very interesting. While the difference between the lowest and highest educated groups among the provincial

TABLE 8.—*Showing average scores of Baguio teachers taken in groups of educational attainment.*

[Q. C. D., Quartile coefficient of dispersion.]

Group.	Men.			Women.		
	Number.	Score.	Q.C.D.	Number.	Score.	Q.C.D.
First-year high school and normal school	46	112.1	0.10	18	95.5	0.19
Second-year high school and normal school	13	116.0	0.11	3	126.3	
Third-year high school and normal school	11	116.1	0.19	7	115.0	0.22
Fourth-year and graduate normal school	47	128.2	0.13	22	125.9	0.09
Fourth-year and graduate high school	16	129.7	0.08	4	106.7	0.07
College graduates and undergraduates	38	129.9	0.13	5	136.8	0.04
Total	166			59		

teachers amounted to more than 50 points, this difference in the Baguio group amounts to but some 17 points (men only). First-year high- and normal-school men in the provincial group scored 73.5, while the same group among the Baguio teachers scored 112.1. The teachers who convene annually at Baguio are among the best teachers in the service. They are carefully selected by their respective division superintendents and sent to Baguio at Government expense to take part in various conferences and to learn of new ideas and methods in education. Tables 4 and 8 would seem to prove that schooling has but a slight influence, even among Filipinos, on the scores obtained in tests of native mental ability.

TABLE 9.—*Showing average scores of various racial types—Baguio group.*

Type.	Men.			Women.		
	Number.	Range.	Average score.	Number.	Range.	Average score.
Malay	52	54–183	121	32	62–158	116
Spanish-mestizo	19	111–152	124	4	128–157	140
Indonesian	40	84–161	125			
Proto-Malay	10	85–166	127			
Chinese-mestizo	19	97–189	132	7	88–171	129

The Baguio group was too small and too carefully selected to bring to light facts of general applicability. However, each individual was classified as to his physical or racial type. Many of the individuals were much mixed, racially, and the classification, therefore, was far from satisfactory. But the average scores of the various racial types are given in Table 9, not so much to indicate the relative intelligence of these Philippine

racial types, but to show that each type contains individuals of high mental ability. The table is given for what it is worth.

Direct comparison between the scores obtained in the Otis scale by Americans and Filipinos would hardly be fair, owing to the different conditions; but, for the sake of completeness, the following American norms are given:

Year.	Score.
8	40
9	52
10	64
11	76
12	88
13	100
14	112
15	121
16	125
17	128
18	130

In a letter to me Doctor Otis says:

> The normal intelligence for adults is considered to be constant for all ages above 18 years and is represented by a score of 130 points. Teachers are considered to be a group above "average" in intelligence and will range from 100 to 200 points in their scores.

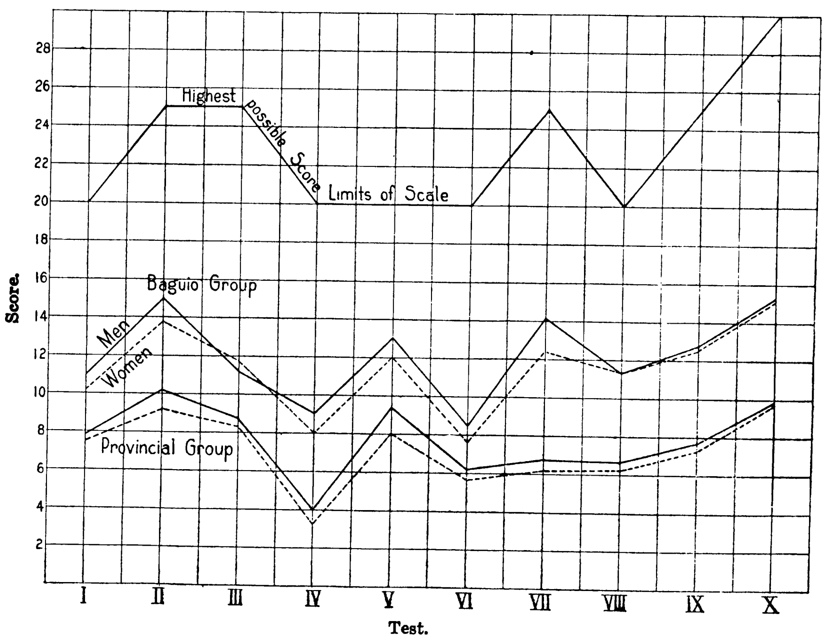

Fig. 3. Average scores in each test separately.

Fig. 3 is a profile graph showing the average performance of both groups in each individual test, for both males and females. It will be seen that both groups scored comparatively low in test 4, which is a test in the interpretation of proverbs. The language element, however, and English idiomatic expression is too considerable an element in this test to make it a fair one for Filipinos. In spite of this fact the results obtained with this test bear a high correlation with the general intelligence score. The same is true of test 7, completing analogies. The results obtained with test 3, arranging disarranged sentences, and with test 6, discriminating between geometric figures, show a lesser correlation with the general intelligence score.

In regard to the relation between the scores of the men and those of the women it appears that the same is true in the Philippines as elsewhere. It will be seen that the difference is least in the tests which involve memory to any large extent. Yerkes and Burtt concluded—

> College men with respect to the majority of the intellectual functions measured by the point scale method, rank higher than college women * * * This superiority of the men is especially marked in tests which involve reasoning and other fairly complex thought processes.[10]

PART THREE

Part three of this paper gives the results of the application of the Yerkes point scale[11] to a number of school children in the Provincial Intermediate and High School at Cuyo, Palawan.

The point scale consists of twenty separate tests, each of which involves the mental functions enumerated in Table 10.

The point scale was slightly adapted as follows:

Test 9: "Orange" substituted for "apple," for the apple is not a tropical fruit; "iron" substituted for "glass," for glass is not common in Cuyo. Test 14: "Cuyo" substituted for "Boston," and "ocean" for "river," for Cuyo cannot boast of a river. Test 15: "Missing the boat" substituted for "missing the train," for few Cuyono children had ever seen anything but the picture of a train. Test 20: "Foot is to shoe" substituted for "hand is to glove," for gloves are about as common in Cuyo as fans in the Arctic region.

Cuyo is a small island, some 8 by 11 kilometers, in the Sulu

[10] Yerkes and Burtt, The Relation of Point-Scale Measurements of Intelligence to Educational Performance in College Students, School and Society (May 5, 1917).

[11] Yerkes, Bridges, and Hardwick, A Point Scale for Measuring Mental Ability. Baltimore (1915).

TABLE 10.—*The point scale tests.*

Test.		Principal mental functions.
1	Æsthetic judgment	Perception, association, analysis.
2	Perception	Apperception, visual memory, imagination.
3	Discrimination	(a) Visual, (b) kinæsthetic.
4	Auditory memory	For words, attention.
5	Memory	Imagination, attention.
6	Auditory memory	For sentences, attention.
7	Perception (visual)	Of things, relations, meanings.
8	Kinæsthetic discrimination	Ideation (notion of series) attention.
9	Analysis and comparison	Of remembered objects, attention.
10	Ideation	Association, analysis.
11	Suggestibility	Visual perception, comparison.
12	Motor coördination	Visual perception.
13	Association (free)	Vocabulary, attention.
14	Imagination and command of language forms.	
15	Practical judgment	Memory, imagination.
16	Visual memory	Perception, attention, motor coördination.
17	Logical judgment	Imagination, analysis, reasoning.
18	Ideation	Analysis, imagination, command of language forms.
19	------do	Vocabulary, memory, analysis.
20	Logical judgment	Analysis, reasoning, attention, memory.

Sea, between the larger islands of Panay and Palawan. The people of Cuyo are Christians, and their culture is the general Spanish-Filipino culture of the Bisayan type. Physically they belong to the Malay blend type, but with the Indonesian B element very prominent.[12] In Cuyo itself there has been some intermarriage with Spaniards. Due to the island's small size and its isolation most of the young men leave it to seek opportunity elsewhere. This has left the number of women far in excess of the men.

The Agutaynos are a people who live on a still smaller island, Agutaya, about 48 kilometers north of Cuyo. Their speech differs considerably from that of the Cuyonos.

Beyer, of the University of the Philippines, says that there is considerable evidence that the Cuyonos and Agutaynos are Christianized Tagbanuas, a pagan group now dwelling in the mountainous interior of Palawan.[12]

In both islands the people are inbred to a considerable extent. Most of the people in Cuyo belong to one of two large families, and nearly everyone is some sort of relative of everybody else.

The data obtained in Cuyo are almost too meager to warrant a special paper, but as I do not expect to visit Cuyo again, I am

[12] Beyer, H. O., Population of the P. I. in 1916 (1917) 49, 73. Also his paper on the Non-Christians in the Census of the P. I. for 1918 2 (1921) 907–957.

forced to make the best of the little I was able to gather during the year of my residence there—1917–1918.

Table 11 shows the classes and numbers of children examined. All of these children were pupils in the fifth, sixth, and seventh grades of the intermediate school or first- or second-year pupils in the high school.

TABLE 11.—*Showing the classes and numbers of children examined in Cuyo.*

Classification.	Boys.	Girls.
Cuyonos	52	12
Agutaynos	17	
Cuyono-Agutaynos	8	1
Spanish-Cuyonos	29	7
Tagalog-Cuyonos	9	1
Chinese-Cuyonos	4	1
American-Cuyonos	3	2
Unclassified	24	6
Total	146	30

TABLE 12.—*Showing the scores of all the boys and girls and their frequencies.*

BOYS.

Age.	No.	Scores and frequencies.	Average.
11	1	60	60
12	5	51, 54, 59, 66, 78	62
13	12	43, 48, 49, 53, 54(2), 58, 62, 64, 65, 70, 81	58
14	8	53, 54, 55, 56, 57, 62, 64, 81	60
15	19	42, 48, 49(2), 53(3), 55, 57, 58, 63, 67, 69, 71, 73, 74, 75(2), 83	61
16	18	48, 54(2), 57(2), 59, 61, 64, 70, 73, 76, 82, 84(2), 86, 87(2), 88	71
17	19	53, 55, 56(2), 60, 61, 66(3), 68, 70, 73(2), 74(2), 77, 78, 84, 85	68
18	28	48, 49, 52, 53(2), 60, 62, 63(2), 67, 71(3), 73, 76, 77, 78, 79(2), 81, 83, 84, 85, 87, 88, 89, 91, 95	72
19	20	52, 57(2), 58, 61, 62(3), 65, 69, 72, 73, 74, 75(2), 79, 81, 83(2), 89	69
20	8	53, 65, 67, 72, 74, 76, 87, 88	73
21	1	61	61
22	2	68, 78	73
23	3	69, 73, 79	74
27	1	67	67

GIRLS.

Age.	No.	Scores and frequencies.	Average.
10	1	59	59
11	3	41, 60, 62	54
12	1	66	66
13	5	55, 65, 66, 74(2)	67
14	8	46, 55, 56, 58, 59, 63, 71, 80	61
15	9	46, 47, 56, 60, 71, 72, 75, 78, 85	66
16	1	77	77
18	1	71	71

Table 12 shows the scores of all the boys and girls, and their frequencies. Table 13 gives the scores of the boys and girls by school grade. Figs. 4 and 5 show the same data graphically. The grade curve (fig. 5) is fairly regular, indicating that the grading in the school showed a close correlation with intelligence. This is as it should be. The age curve (fig. 4) is not so regular. The poor performance of the older pupils is due, of course, to

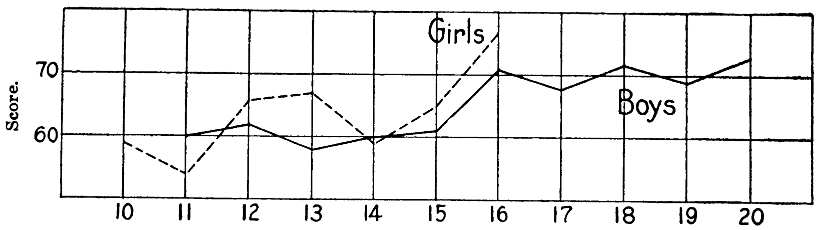

FIG. 4. Average scores of all the boys and girls from 10 to 20 years of age.

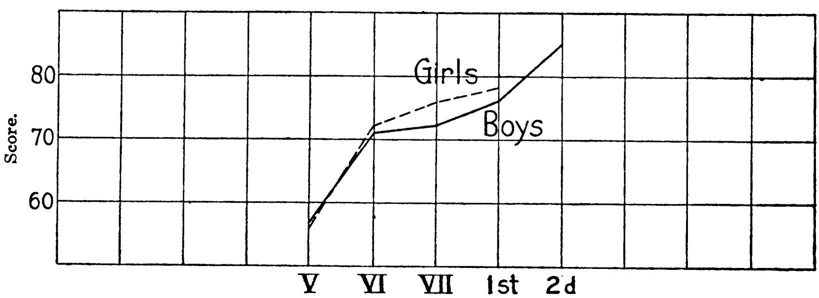

FIG. 5. Scores of boys and girls by school grade.

the fact that they were repeaters in their grades with all that that means. It will be seen that the girls, at least between the ages of 12 and 16, did better than the boys. Somewhat similar results have been brought out in America.[13]

Table 14 gives the averages at different ages for the pure Cuyonos and Agutaynos and for the various mestizo groups. Fig. 6 shows the difference between the scores of the Cuyonos and Agutaynos, the latter ranking much lower. Fig. 7 is a comparison of the scores of the Spanish- and Tagalog-Cuyono mesti-

[13] Yerkes, Bridges, and Hardwick, A Point Scale for Measuring Mental Ability. Baltimore (1915) 69 f.; Stern, Psychological Methods of Testing Intelligence. Baltimore (1914) 65 f.; Terman, The Measurement of Intelligence. New York (1916) 68 f.

zos with those of the pure Cuyonos. The mestizos are seen to be superior. Fig. 8 shows the superiority of the combined mestizo groups over the pure Cuyono group by ages. The results are rather striking; but the insufficiency of the data does not allow of many generalizations. It may be said, however, with little chance of error that the inbred Cuyono strain is enriched by intermixture with outside blood.

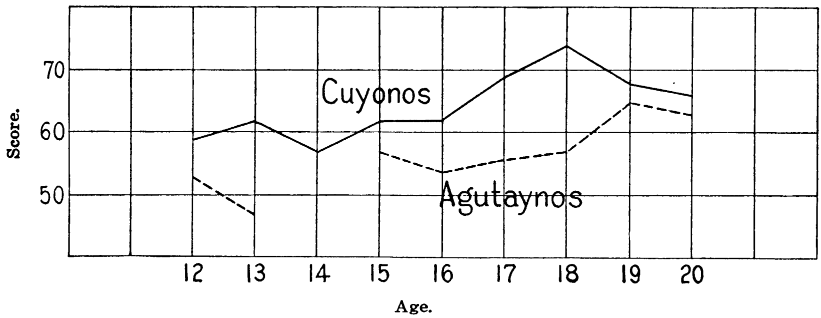

FIG. 6. The difference between the scores of Cuyonos and Agutaynos.

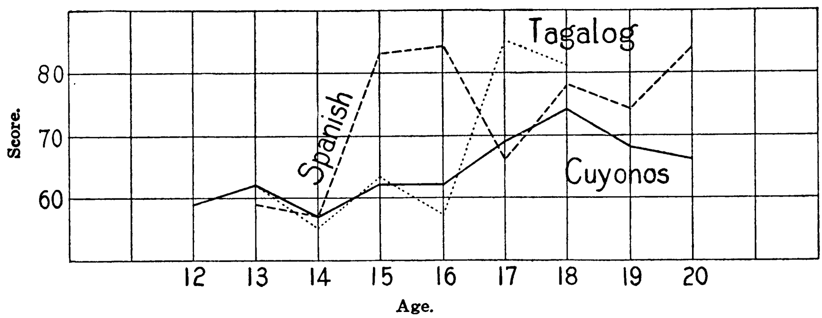

FIG. 7. Comparison of the scores of Spanish-Cuyono and Tagalog-Cuyono mestizos with the scores of pure Cuyonos.

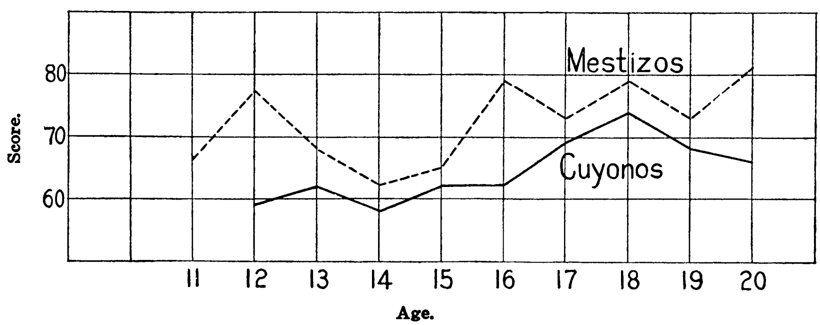

FIG. 8. Showing the superiority of the combined mestizo groups over the pure Cuyono group.

TABLE 13.—*Showing scores of boys and girls by school grade.*

Grade.	Number.	Scores and frequencies.	Score Average.	Age. Range.	Age. Average.
		BOYS.			
V	65	42, 43, 48(4), 49(4), 51, 52(2), 53(8), 54(6), 55(3), 56(2), 55(3), 56(2), 57(5), 58(3), 59(2), 60(2), 61(3), 62(3), 63(2), 64(3), 65(2), 66, 67(2), 68, 70(2), 78, 81	57	11-21	15
VI	6	56, 71(2), 72, 74, 81	71	13-19	16
VII	37	53, 57, 60, 62(2), 65, 66(2), 67(2), 68, 69(3), 71(2), 72, 73(4), 74, 75(3), 76(2), 77, 78, 79, 81, 83, 84, 85, 87, 88	72	15-23(27)	18(22)
I H. S.	24	62, 63, 66(2), 70, 73(3), 74(3), 75, 76, 77, 78, 79(2), 82, 83(2), 84, 85, 87, 88	76	15-23(27)	18(19)
II H. S.	14	78, 79, 81, 83, 84(2), 86, 87(2), 88, 89(2), 91, 95	85	16-20	18
		GIRLS.			
V	17	41, 46(2), 47, 55(2), 56(2), 58, 59(2), 60, 62, 63, 65, 66(2)	56	10-15	13
VI	7	60, 71(2), 74(2), 77, 78	72	14-18	15
VII	3	71, 72, 85	76	15	15
I H. S.	2	75, 80	78	14-15	15

TABLE 14.—*Showing the averages at different ages for the pure Cuyonos and Agutaynos and for the various mestizo groups.*

Type and sex.	Age	Scores and frequencies.	Average.
Cuyono boys	12	59	59
Do	13	54, 58, 64, 70	62
Do	14	54, 56, 62	57
Do	15	49, 49, 53, 55, 58, 67, 74, 75, 75	62
Do	16	48, 54, 57, 59, 61, 64, 73, 82	62
Do	17	61, 66, 68, 70, 73, 74, 74	69
Do	18	49, 62, 63, 71, 76, 77, 79, 81, 83, 84, 89	74
Do	19	57, 61, 62, 65, 69, 73, 75, 81	68
Do	20	65, 67	66
Do	21	61	61
Cuyono girls	10	59	59
Do	13	55, 65, 74	65
Do	14	55, 56, 58, 59, 63	58
Do	15	47, 71	71
Do	18	71	71
Agutayno boys	11	60	60
Do	12	51, 54	53
Do	13	43, 48, 49	47
Do	15	48, 53, 71	57
Do	16	54	54
Do	17	53, 55, 56, 56, 60	56

TABLE 14.—*Showing the averages at different ages for the pure Cuyonos and Agutaynos and for the various mestizo groups*—Continued.

Type and sex.	Age.	Score and frequencies.	Average.
Agutayno boys	18	48, 52, 53, 53, 63, 71	57
Do	19	58, 72	65
Do	20	53, 72	63
Do	22	68	68
Do	23	73, 79	76
Agutayno girls	11	41	41
Do	14	71	71
Do	15	56, 75	66
Spanish-mestizo boys	11	66	66
Do	13	53, 65	59
Do	14	57	57
Do	15	83	83
Do	16	76, 84, 87, 87	84
Do	17	66	66
Do	18	60, 67, 73, 78, 79, 85, 87, 95	78
Do	19	57, 58, 74, 75, 79, 83, 89	74
Do	20	76, 87, 88	84
Spanish-mestiza girls	11	60, 62	61
Do	12	66	66
Do	13	66, 74	70
Do	15	72, 78	75
Cuyono-Agutayno mestizo boys	14	53	53
Do	15	42, 63, 73	59
Do	17	66, 73, 77	72
Do	22	78	78
Cuyono-Agutayno mestiza girls	15	60	60
American-Cuyono mestizo boys	12	78	78
Do	13	81	81
Do	14	81	81
American-Cuyono mestiza girls	15	85	85
Do	16	77	77
Chinese-Cuyono mestizo boys	16	70, 78, 88	79
Do	19	62, 83	73
Chinese-Cuyono mestiza girls	14	80	80
Tagalog-Cuyono mestizo boys	13	62	62
Do	14	55	55
Do	15	57, 69	63
Do	16	57	57
Do	17	85	85
Do	18	71, 91	81
Do	20	74	74
Tagalog-Cuyono mestiza girls	14	46	46

Table 15 shows the performance of the pure Cuyonos and the combined mestizo groups in each separate test. The table is not exact, for the averages are based on mere inspection, but it will serve to bring out the general facts.

For the sake of completeness the following norms for children of non-English-speaking parents in America are given. How-

ever, the Cuyono pupils were at a social and lingual disadvantage even to these.[14]

TABLE 15.—*Performance of pure Cuyonos and combined mestizo groups in each test.*

Test.	Maximum credits.	Cuyonos.	Mestizos.
1	3	3	3
2	4	4	4
3	3	3	3
4	5	3	4
5	4	4	4
6	6	2	3
7	9	6	7
8	2	2	2
9	6	6	6
10	8	6	7
11	3	2	2
12	4	4	4
13	4	2	3
14	4	3	4
15	8	2	4
16	4	3	3
17	5	2	3
18	6	3	5
19	6	1	2
20	6	2	3
Total	100	63	76

TABLE 16.—*Point-scale norms for children of non-English-speaking parents in America.*

Age.	Scores.	
	Boys.	Girls.
Years.		
9	46	51
10	58	55
11	61	65
12	66	68
13	66	75
14	74	76
15	69	76

[14] Yerkes, Bridges, and Hardwick, A Point Scale for Measuring Mental Ability. Baltimore (1915) 72.

ILLUSTRATIONS

TEXT FIGURES

PRESSURES REQUIRED TO CAUSE STOMATAL INFECTIONS WITH THE CITRUS-CANKER ORGANISM

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TWO TEXT FIGURES

In the study of citrus canker, there have been found several species of *Citrus* with more or less resistance to the disease. Notable among such resistant species are the mandarin orange varieties which in the orchards of heaviest infection in Japan, China, and the Philippines remain almost entirely free from the disease. In connection with this disease resistance, interest is naturally stimulated to investigate the characters of the disease-free varieties which determine their resistance. With fungus diseases on various hosts, it has been shown in many instances that leaf-attacking fungi send mycelial threads from their spores, through the stomata. Leaf-attacking bacteria, such as the citrus-canker organism, which are motile in water, possibly can enter through the stomata, if the stomatal pores are filled with water. It seems scarcely probable that they would be carried through the stomata in the dry state, under usual circumstances.

The authors [1] have shown in previous papers that the resistance to canker of the mandarin orange is due to some character of the epidermis of that species. It was further shown by the senior writer [2] that the stomata of the mandarin orange, the resistant form, differed markedly from the structure of such a very susceptible species as the grapefruit. These differences

[1] McLean, Forman T., and Lee, H. Atherton, The resistance to citrus canker of Citrus nobilis and a suggestion as to the production of resistant varieties in other species, Phytopath. 11 (1921) 109–114a.

[2] McLean, Forman T., A study of the structure of the stomata of two species of Citrus in relation to citrus canker, Bull. Torrey Bot. Club 48 (1921) 101–106.

have further been shown to cause the leaves of grapefruit to be more permeable to water than are those of the more canker-resistant mandarin orange.[3] It was also demonstrated in another paper that water could be forced through the uninjured stomata of grapefruit by the application of comparatively little pressure.

The above-mentioned studies strongly suggested that the differences in structure of the stomata and permeability of the leaves of mandarin and grapefruit are responsible for the resistance to canker of the former and the susceptibility of the latter. At this stage of the investigations it seemed desirable to attempt by some means to introduce the canker bacteria within the leaf tissue of the resistant mandarin orange variety without mechanical injury; if canker resulted it would be apparent that the tissues were not dependent on injury to render them susceptible. Moreover, the development of canker lesions on this host, after withdrawing the air from the stomata, would substantiate the theory that it is the peculiar structure of the stomata in the leaves of the mandarin orange that contributes to resistance.

In the study here reported, a method has been devised for drawing water into intact leaves on the tree in the orchard, by the use of known and easily measurable pressure. Canker has been produced in young leaves of the mandarin orange, grapefruit, and pummelo by substituting an infusion of *Pseudomonas citri* Hasse for the water. The experiments are described in the following paragraphs.

APPARATUS AND PROCEDURE

The device used to force water and canker organisms into the citrus leaves was an adaptation of the porometer.[4] It consisted of a suction tube with a rubber lip for pressing against the leaf, a mercury pressure gauge connected with it to indicate the reduced pressure in the suction tube, and a simple aspirator, also connected with the suction system, the rate of withdrawal

[3] McLean, Forman T., The permeability of Citrus leaves to water, Philip. Journ. Sci. 19 (1921) 115–123.

[4] Darwin, F., and Pertz, D. F. M., A new method of estimating the aperture of stomata, Proc. Roy. Soc. London, Ser. B, No. B569 (1911) 136–154; Trelease, Sam F., and Livingston, B. E., The daily march of transpiring power as indicated by the porometer and by standardized hygrometric paper, Journ. Ecol. No. 1 4 (March 1916) 1, abs. in Science New Ser. 43 (1916) 363.

of air from the suction system into the aspirator being controlled by a screw pinchcock (see fig. 1). The operation of the apparatus was very simple. Mercury was sucked up into the aspirator tube, with the screw pinchcock closed. The suction tube was then closed at the bottom by a pinchcock, and the screw cock

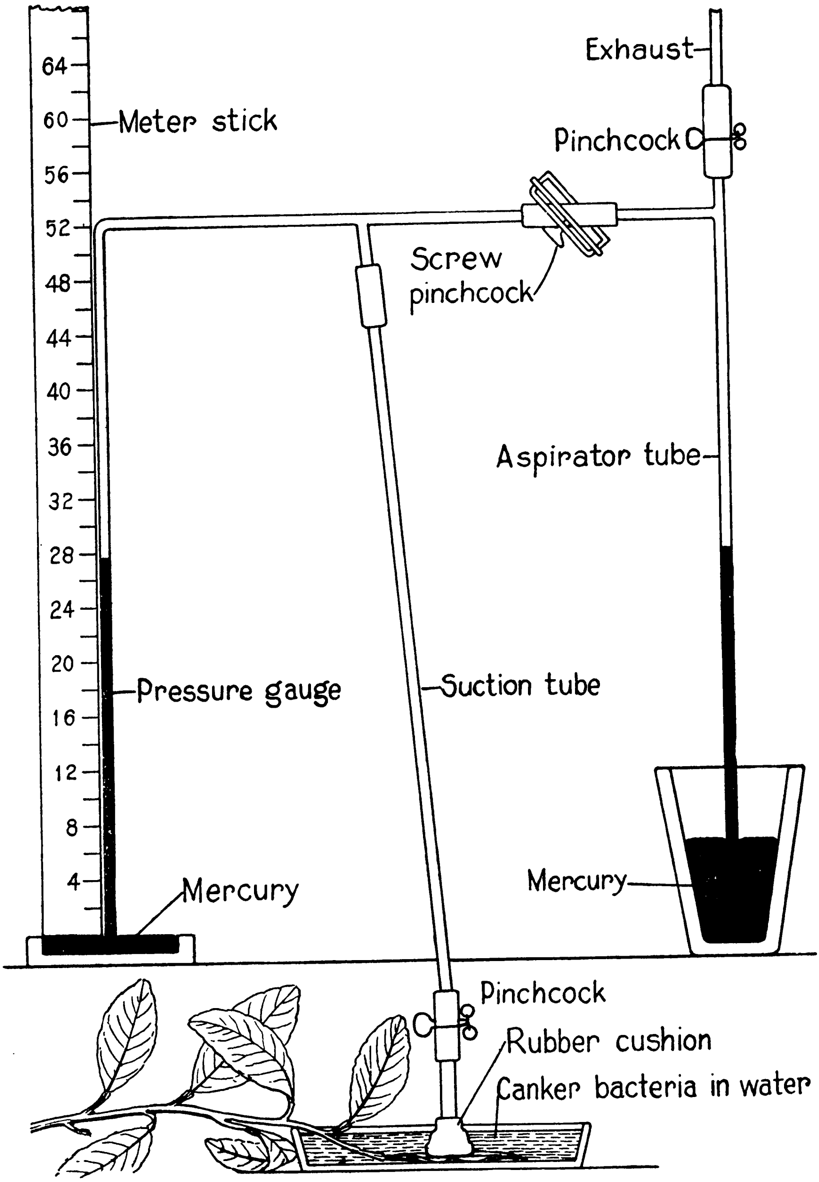

FIG. 1. Apparatus used to inject leaves with citrus-canker organisms.

cautiously opened, allowing the air to be withdrawn from the suction system until the desired reduction in atmospheric pressure was indicated in the pressure gauge. The suction tube was then applied to the under surface of a citrus leaf, which was immediately submerged in an infusion of the citrus-canker bacteria. The pinchcock was then opened and suction thus applied to the leaf surface. This caused withdrawal of air from the leaf through the stomata in the same manner as with a porometer, except that in this case, the leaf being submerged, air could not enter, and thus the pressure of the air inside the leaf was ultimately reduced to the same amount as in the suction tube.

It was found that, by reducing the pressure in the apparatus and leaf sufficiently, the infusion would be drawn into the leaf tissues by atmospheric pressure and hydrostatic pressure combined. The hydrostatic pressure was of course low as compared to the differences in pressure between the atmosphere and the apparatus, since the dish in which the leaves were submerged was filled with liquid to a depth of about 3 centimeters only. The presence of water in the intercellular spaces of the leaf could only be detected when these were flooded. For this reason it is quite probable that small amounts of water might, under pressure, enter the leaves through the stomata without being detected. Injection was only recorded when the intercellular spaces of the leaf were evidently flooded in spots. This visible injection in most cases occurred at a considerable distance from the suction tube (the injector), thus clearly demonstrating that the reduced pressure caused by the suction tube extended throughout the internal air spaces of the leaf.

The injection usually appeared at first as a single translucent spot on the leaf, which gradually spread and was generally followed by the appearance of several other spots at different points. If the pressure inside the leaf was not still further reduced after injection was first observed, these spots did not spread rapidly nor involve a very large part of the leaf. Frequently the spread of the spots stopped after they had attained a diameter of 1 or 2 millimeters. From these facts it was deemed probable that still smaller amounts of water might, in some cases, have been drawn into the leaf with less extreme pressure without being detected.

INJECTION TESTS

In April and May, 1921, during the dry season, a number of tests were made of the pressure required to inject water into

citrus leaves, using the apparatus described above.[5] The results of these determinations showed clearly that the permeability varies greatly for leaves of the same age and on the same tree, so that large numbers of readings are necessary to establish satisfactory averages.

The Szinkom mandarin orange variety employed in the experiments is a variety successfully grown in the Philippines; although introduced here from India, it is believed to be a native of China. It is one of the most canker-resistant horticultural varieties of any of the citrus species. The grapefruit trees employed in the experiment were in a few cases of the Pernambuco variety, and in others of a seedling variety, all rather susceptible, according to field observations. Since grapefruit leaves were not sufficiently abundant, a susceptible pummelo variety was chosen to complete the comparative tests. The pummelo trees were of the East Indian type, also known as shaddocks; they also were matured seedlings. In the field, from the amounts of natural infection, one would judge these trees employed in the experiments to have much the same degree of susceptibility as the grapefruits. The results with four *Citrus* varieties are summarized in Table 1.

TABLE 1.—*Results of application of pressure on leaves of Citrus species immersed in water.*

Variety.	Tests.	Pressures causing injection.		
		Average.	Highest.	Lowest.
		cm.	*cm.*	*cm.*
Pernambuco grapefruit	60	19.5	53.0	10.0
East Indian pummelo	130	19.6	55.0	5.5
Washington navel orange	75	20.8	50.5	9.0
Szinkom mandarin orange	18	33.6	55.0	11.8

The range of values from the highest to the lowest seems to be about the same for all varieties tested. The highest value, 55 centimeters, represents the highest mercury column attainable with the apparatus, and a number of leaves failed to be injected even with this extreme pressure. The average values appear to be more significant, the more-susceptible grapefruit and pummelo being the easiest to inject and the highly resistant Szinkom mandarin orange the most difficult, the Washington

[5] Most of these tests were made by S. Bacol, R. Cuitiong, M. Punzalan, F. Esguerra, F. Rodis, and T. Bautista, all advanced students in plant nutrition, working under the direction of the senior author.

navel orange being intermediate both in injection pressure and canker resistance. The comparisons of the average injection pressures thus apparently indicate that injection pressure is an approximate index of resistance to citrus canker. The work was then repeated, substituting an infusion of *Pseudomonas citri* for the water-bath immersion.

INJECTION TESTS WITH INFUSION OF PSEUDOMONAS CITRI

In the following experiments young, actively growing leaves were used of such condition as to be judged readily susceptible to infection with *Pseudomonas citri*. The leaves were in all cases on mature orchard trees, growing under identical environmental conditions.

The infusion used was made from cultures of *Pseudomonas citri* on potato plugs. The cultures used were of the same age, and in comparative tests the same infusion was used. The temperature of the infusion during the experiment varied between 28° and 31° C.

In a few cases, cankers developed at the point of contact of the injector with the leaf. These cankers were recorded as at wounds. The cankers not so noted were on apparently uninjured parts of the leaves and at a distance from the point of injector contact.

The experimental results are presented in Tables 2, 3, and 4.

TABLE 2.—*Showing the results of immersing leaves of the Szinkom mandarin orange in an infusion of Pseudomonas citri and exerting graduated degrees of pressure upon such leaves.*

Pressure of mercury column.	Twig No.	No. of leaf from tip of twig.	Condition of leaves.	Incubation period.	Cankers.
cm.				*Days.*	
0.0	4	8	Full grown	11	None.
0.0	4	9	do	11	Do.
0.0	4	10	do	11	Do.
0.0	6	3	do	11	Do.
0.0	8	1	Half grown	11	Do.
0.0	8	2	Two-thirds grown	11	Do.
0.0	8	3	do	11	1[a]
0.0	11	1	One-fourth grown	26	1
0.0	11	2	Half grown	26	1
0.0	11	3	do	26	4
2.4	3	3	do	11	1
2.5	1	1	Two-thirds grown	11	None.
2.5	7	1	Full grown	11	Do.
2.8	9	4	Two-thirds grown	26	5[b]

[a] Infection at evident wound. [b] Character of infection suggests wounds.

TABLE 2.—*Showing the results of immersing leaves of the Szinkom mandarin orange in an infusion of Pseudomonas citri and exerting graduated degrees of pressure upon such leaves*—Continued.

Pressure of mercury column.	Twig No.	No. of leaf from tip of twig.	Condition of leaves.	Incubation period.	Cankers.
cm.				*Days.*	
3.7	6	1	Half grown	11	None.
4.0	3	2	do	11	Do.
5.0	1	2	Two-thirds grown	11	Do.
5.0	4	7	Full grown	11	Do.
5.0	7	4	Three-fourths grown	11	Do.
5.1	9	3	do	26	Do.
5.5	3	1	Half grown	11	Do.
5.6	6	2	Full grown	11	Do.
7.3	3	5	Half grown	11	Do.
7.5	7	3	Two-thirds grown	11	Do.
8.0	4	1	One-third grown	11	Do.
9.5	7	2	Half grown	11	3[a]
10.0	1	3	Two-thirds grown	11	None.
10.0	3	4	Half grown	11	2
10.2	9	2	Two-thirds grown	26	
10.5	5	4	Full grown	11	None.
10.5	4	6	do	11	6
11.4	10	1	Half grown	26	5
12.0	7	1	do	11	None.
12.2	10	2	Three-fourths grown	26	1
12.4	3	8	Full grown	11	None.
13.4	9	1	Half grown	26	Numerous.[c]
14.0	10	3	Three-fourths grown	26	1[b]
14.4	3	7	do	11	None.
14.4	4	5	Two-thirds grown	11	Do.
[a]15.5	5	3	Full grown	11	1
16.0	1	4	Three-fourths grown	11	None.
[d]16.2	5	5	Full grown	11	Do.
18.0	4	2	One-third grown	11	4[a]
[d]19.0	3	6	Three-fourths grown	11	Numerous.
[d]19.9	10	4	Full grown	26	Do.
20.2	2	2	One-third grown	11	
[d]20.5	5	2	Three-fourths grown	11	Numerous.
[d]21.0	4	4	Half grown	11	10
21.0	2	1	Two-thirds grown	11	
[d]21.5	9	6	Full grown	26	Numerous.
[d]21.8	9	5	do	26	4
[d]26.7	5	1	Two-thirds grown	11	Numerous.
[d]42.0	4	3	Half grown	11	Do.

[a] Infection at evident wound.

[b] Character of infection suggests wounds.

[c] Numerous; this observation was recorded only when the cankers were present so abundantly as to make an accurate count impossible.

[d] Leaf injected with infusion at the pressures recorded.

To summarize briefly the results recorded in Table 2, with a very few exceptions immersion of Szinkom mandarin orange

leaves, with low pressures exerted, resulted in no infection. Up to the pressures registered with the mercury column at 10 centimeters the results were largely negative. The few exceptions to this are easily understandable from the notes from the field notebook, appended below the table; nevertheless, the results from twig 11 do not seem possible of explanation from the recorded data. It only seems possible that the twig was abnormal, or that some slight insect attack resulted shortly after immersion of the leaves. With the exception of this one twig the results are completely consistent. Even above the pressures of 10 centimeters there was no general infection until pressures

TABLE 3.—*Showing the results of immersing leaves of a grapefruit seedling tree in an infusion of Pseudomonas citri and exerting graduated degrees of pressure upon such leaves.*

Pressure.	Twig No.	No. of leaf from tip of twig.	Condition of leaves.	Incubation period.	Cankers.
cm.				*Days.*	
0.0	1	1	One-third grown	10	None.
0.0	1	7	Full grown	10	2[a]
0.0	1	8	do	10	None.
0.0	2	1	One-third grown	10	Numerous.[b]
0.0	2	2	do	10	Do.
0.0	2	10	Full grown	10	None.
0.0	2	11	do	10	2
0.0	3	4	Three-fourths grown[c]	27	Numerous.
2.0	2	9	Full grown	10	2
2.5	1	2	Half grown	10	None.
4.5	2	8	Full grown	10	2
5.0	3	7	do	27	Numerous.
5.3	1	3	Half grown	10	1
6.5	1	4	Two-thirds grown	10	None.
7.7	3	6	Full grown	27	Numerous.
8.0	2	7	do	10	None.
[d]8.2	1	5	Three-fourths grown	10	Do.
10.0	2	6	do	10	Numerous.
10.1	3	5	Full grown	27	Do.
10.4	3	1	Half grown	27	3
12.5	2	5	Three-fourths grown	10	8
[d]13.0	1	6	Full grown	10	1
[d]14.3	3	2	Half grown	27	Numerous.
14.4	3	3	do	27	Do.
15.0	2	4	do	10	Do.
[d]18.0	2	3	One-third grown	10	Do.
[d]28.0	3	8	Full grown	27	Do.

[a] At wounds.

[b] Numerous; this observation was recorded only when an accurate count of the cankers was impossible because of their number.

[c] Leaf-miner injuries present.

[d] Injected.

with the mercury at 19 and 20 centimeters and above were reached.

For comparison with these results Tables 3 and 4 of grapefruit and pummelo tests are given.

TABLE. 4.—*Showing the results of immersing leaves of a pummelo seedling tree in an infusion of Pseudomonas citri and exerting graduated degrees of pressure upon such leaves. Incubation period twenty-seven days.*

Pressure.	Twig No.	No. of leaf from tip of twig.	Condition of leaves.	Cankers.
cm. 0.0	1	5	Two-thirds grown	Numerous.
0.0	2	1	One-fourth grown	None.
0.0	3	4	Two-thirds grown	Numerous.
0.0	4	6	Full grown	Several.
0.0	5	4	Three-fourths grown	Numerous.
3.1	2	5	Half grown	Do.
4.7	2	2	do	Do.
5.0	3	1	One-third grown	Do.
5.2	4	5	Full grown	Do.
7.3	2	3	Half grown	Do.
7.6	4	4	Three-fourths grown	Do.
7.8	3	2	Half grown	Do.
8.8	5	6	Full grown	Do.
9.6	3	3	Half grown	Leaf fallen.
9.6	1	4	Two-thirds grown	Numerous.
10.0	4	2	Half grown	Do.
10.0	5	5	Three-fourths grown	Do.
10.2	4	3	Two-thirds grown	7
10.9	5	3	do	Numerous.
[a]11.2	1	2	do	Do.
[a]11.9	5	2	do	Do.
[a]12.3	4	1	Half grown	Do.
[a]13.0	5	1	Two-thirds grown	Do.
13.3	3	5	do	Leaf fallen.
17.0	1	1	Half grown	Numerous.
35.0	1	3	Two-thirds grown	Do.

[a] Injected.

Whereas in the Szinkom mandarin orange infection of leaves took place mainly at pressures recorded by 10 centimeters of mercury and higher, in the tests of grapefruit leaves shown in Table 3 infection took place readily, either without pressure or at very low pressures. Five of the seven negative results with grapefruit were on twig 1, which was on a separate tree and was apparently more resistant than the others. Although the results are not so consistent as in Table 1, it is very evident that abundant infection took place at much lower pressures

than in the case of the Szinkom mandarin orange. Infections were numerous at pressures indicated by 10, 7, and 5 centimeters of mercury, and even with only the almost negligible hydrostatic pressure of the liquid in which the leaves were submerged.

In Table 4 results on pummelos are recorded.

The results of the tests recorded in Table 4 are uniformly positive, with the single exception of leaf 1, twig 2. It is evident that at very low mercury pressures, and even with simple immersion, the citrus-canker organism gains ready access to the tissues of the leaves of this host.

The observed injection pressures shown in Tables 1, 2, 3, and 4 are much higher than the pressures which cause canker infection, thus indicating that water and canker organisms are drawn into the leaf tissues at lower pressures than those causing visible injection. The pressure causing visible injection thus appears to be roughly proportionate to that necessary for infection, but not identical with it.

DISCUSSION OF RESULTS

It is apparent from the foregoing results that canker will develop in the leaves of the mandarin orange, even in the absence of injury to the tissues, once the canker bacteria have gained entrance into the leaf.

It has been concluded from the results presented in the papers previously listed, that the resistance to citrus canker of the mandarin orange varieties is due to mechanical peculiarities of structure, and that such mechanical peculiarities apparently exist in the epidermis. It was also shown that the character of the stomata of the mandarin orange was such as to prevent the ready ingress of water; the results just presented, moreover, show that in the mandarin orange pressure is required to draw the water into the stomata. On the other hand, it has been shown that the stomata in the grapefruit are of such a structure as to fill readily with water, and the foregoing experiments indicate that simple immersion is sufficient to fill the stomata with water and cause stomatal infections.

The present results, therefore, rather definitely support the theory previously advanced that the resistance of the mandarin orange is dependent upon its stomatal structure and that the structural differences in the stomata of the mandarin orange and grapefruit and pummelo constitute at least one cause for their differences in susceptibility to citrus canker. The struc-

ture of the stomata of the mandarin orange is such as to exclude water, thus preventing the ingress of the canker bacteria. The structure of the stomata of the grapefruit is such as readily to allow the ingress of water on the surface of the leaf, thus

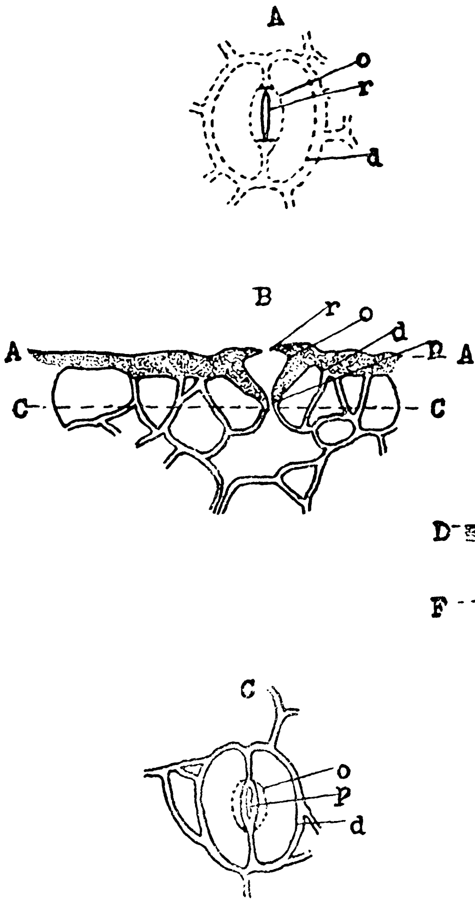

FIG. 2. A, B, and C, stomata of Szinkom mandarin orange, × 570: A, surface view; B, median cross section; C, underview. Showing ridge of entrance, *r;* outer chamber, *o;* pore, *p;* and dorsal wall of guard cells, *d.* D, E, and F, stomata of Florida seedling grapefruit, × 570, showing same parts as A, B, and C.

permitting the entrance of the canker bacteria. Text fig. 2 shows these stomatal differences; the figure is taken from the senior writer's paper previously mentioned.[6]

[6] McLean, Forman T., A study of the structure of the stomata of two species of Citrus in relation to citrus canker, Bull. Torrey Bot. Club 48 (1921) 101–106.

SUMMARY

1. A method is outlined of applying measurable pressure to *Citrus* leaves and determining by this means the pressures necessary to cause penetration of such tissues by water.

2. Leaves of Szinkom mandarin orange, Washington navel orange, seedling East Indian pummelo, and Pernambuco grapefruit were tested by this method to determine their comparative injection pressure with water.

Tests of the injection pressures of *Citrus* leaves gave the following results: The average pressure for Pernambuco grapefruit was 19.5 centimeters of mercury; seedling East Indian pummelo, 19.6; Washington navel orange, 20.8; and Szinkom mandarin orange, 33.6.

3. The average injection pressures of the above four varieties are directly proportional to their canker resistance, as shown by field observations.

4. Leaves of Szinkom mandarin orange, a resistant variety of *Citrus*, and seedling grapefruit and pummelo trees, both very susceptible, were tested for their resistance to the entrance of canker organisms applied in water under pressure. Szinkom mandarin orange leaves were resistant to canker infection by immersion, and up to pressures of 10 centimeters of the mercury column. With high pressures numerous cankers developed in leaves of this variety. Grapefruit and pummelo leaves developed canker readily by immersion without added pressure.

The pressures necessary to cause canker infection were thus in agreement with the degree of observed field resistance of the sorts tested.

5. The results obtained strongly substantiate the theory previously advanced that structural differences in the stomata constitute one cause for the differences in susceptibility of the mandarin orange and the grapefruit and pummelo varieties. In the mandarin orange apparently the structure of the stomata prevents the ingress of surface water; in the grapefruit the stomatal structure is such as to allow the ingress of surface water which thus affords a medium of entrance for the canker bacteria.

6. The results definitely indicate that the resistance of the mandarin orange is due to mechanical structural differences.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Apparatus used to inject leaves with citrus-canker organisms.
2. Stomata of Szinkom mandarin orange; × 570.

THE SCHICK REACTION IN FILIPINOS

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Of the Bureau of Science, Manila

FOUR PLATES

The Schick reaction consists of the injection of a certain amount of diphtheria toxin into the skin of a person in order to determine the presence of the corresponding antitoxin. The negative reaction indicates the presence of at least 1/30 to 1/20 of a unit of a diphtheria antitoxin per cubic centimeter of the blood serum, which amount is usually sufficient to protect the individual from an attack of diphtheria. The positive reaction indicates either a lower content or the total absence of antitoxin in the blood, and the individual is presumably susceptible to the disease.(8, 4) Therefore, the reaction is a means of determining the presence of antitoxic immunity, either natural or acquired, and it is now being widely used for the control of diphtheria contacts, and also as an index in the immunization of persons against the disease.

In a former paper (2) mention was made of the relative infrequency of diphtheria in the Philippine Islands in spite of the presence here of virulent diphtheria bacilli. It has been deemed of interest, therefore, to study the Schick reaction among Filipinos in order to obtain an idea of their immunity to the disease that may help to explain the relatively low incidence of the disease among them.

MATERIAL AND METHOD

The tests were performed on Filipinos, from infants 6 months old to adults of all ages, and at various times from October, 1919, to October, 1921. The cases tested were inmates of Government institutions; the baby nurseries at Singalong and Tondo, which gave us the material for infants and young children; the Government Orphanage at San Pedro Macati and the Boys' and Girls' Reformatories, where the inmates were children and boys and girls of school age; the San Lazaro Hospital Insane Asylum and Bilibid Prison, where the cases were adults of both sexes.

Two intradermal injections were made in the majority of the cases, one on the anterior surface of each forearm. On the right forearm the toxin was injected and on the left forearm the control.

The toxin used in our work was three years old, prepared by the Bureau of Science; the original minimum lethal dose was 0.01 cubic centimeter and at the time these tests were made it was 0.05 cubic centimeter as determined by repeated inoculation of guinea pigs weighing from 250 to 300 grams. The test dose was 0.02 minimum lethal dose diluted to 0.1 cubic centimeter with sterile physiological salt solution.

The control used was either toxin overneutralized with antitoxin in the proportion of 0.02 minimum lethal dose to 0.2 unit of antitoxin, the volume of the injection being made to 0.1 cubic centimeter by the addition of sterile physiological salt solution, or toxin 0.02 minimum lethal dose heated for five or ten minutes at 75° C. In many cases controlled by the injection of toxin heated for five minutes, both arms showed reactions, although in the control in some cases the reaction developed to a lesser degree, suggesting that five minutes' heating was not sufficient to destroy all the toxin. In these cases the test was repeated, using the control toxin heated for ten minutes.

The tests of the control solutions by intracutaneous injection in guinea pigs(7) showed reddening and œdema at the end of twenty-four hours at the site injected with 0.02 minimum lethal dose toxin heated to 75° C. for five minutes; the site of the injection of the toxin heated for ten minutes and that of the toxin-antitoxin mixture showed no changes, as compared with the œdema and necrosis produced by the intradermal injection of free unheated toxin.

In our first tests no control injections were made, but three months afterwards those that showed reaction were retested with corresponding control injections. Incidentally, as was to be expected, we found that the first injection of toxin was not sufficient to confer immunity, as is graphically shown in Plate 3.

By means of syringes graduated in hundredths, such as are usually employed in tuberculin injections, and fine platinum needles, the amount of the substance for the Schick test or the control was injected slowly into the skin, between the epidermis and the dermal layer, which produced a wheallike swelling with the pores of the skin made prominent. The injections were easily made and fairly accurate when the needles used were

sharp and were introduced with the beveled surface toward the epidermis, and when there were no leaks in the syringes.

INTERPRETATION OF THE REACTION

The positive Schick reaction was shown by the appearance around the site of injection of a clearly defined area of redness and infiltration which lasted more than one week, leaving more or less pigmentation which disappeared usually in about a couple of weeks. In some cases the reaction was so marked as to produce sudaminiform eruptions, superficial necrosis, and blisters which desquamated on drying and left deep pigmentations for a considerable length of time (Plates 1 to 3). The negative reaction was judged by the entire disappearance of the redness and tumefaction, due to traumatism of the injection, inside of two days, leaving at most a small pigmented point at the site of the entrance of the needle.

Pseudoreaction, which was manifested by a less-defined area of redness and infiltration, disappearing usually inside of two days, was frequently noted; in adult subjects it at times lasted longer, leaving a small reddish pigmented area at the end of one week which was difficult to distinguish, in many cases, from true reaction, unless the test was properly controlled (Plate 4). The pseudoreaction occurred very seldom in young children, and what positive reaction they showed was so typical that later on no control injections were made on children below 4 years of age, as they were considered unnecessary.

Inspection of the injections was usually made at the end of one, two, and three days, and one week, and the reactions that were considered doubtful were repeated, using different methods of control. There was no difficulty in passing judgment on strong positive reactions, but in those cases in which the reaction was weak or doubtful, careful comparison with control was made from day to day; and if, at the end of one week, the site of the unheated toxin definitely showed more pigmentation than the control, the reaction was considered positive.

SUMMARY AND DISCUSSION OF FINDINGS

The findings are shown in Table 1. In all 1,030 individuals of various ages were tested: 698 males and 332 females. Eighty-eight, or 8.5 per cent, of the 1,030 people examined were positive. The table shows that most of the positives were found during the first eight years of life, especially during early infancy and childhood. The number of positives de-

creased considerably from the age of 8 years up to the adult period. The females, as a general rule, showed a greater number of positive reactions than the males; they averaged 14 per cent of the total number of females examined, whereas the males only showed 5.8 per cent of positives. We also noted similarity in reaction in several groups of brothers and sisters in the Government Orphanage; and where differences were found, the younger ones gave the positive reactions.

TABLE 1.—*Schick reaction in Filipinos.*

Age.	Male.			Female.			Total.		
	Cases.	Positive.		Cases.	Positive.		Cases.	Positive.	
Years.		*Cases.*	*Per ct.*		*Cases.*	*Per ct.*		*Cases.*	*Per ct.*
Less than 1	.7	5	71	3	1	33	10	6	60
1 to 2	7	5	71	2	1	50	9	6	66.6
2 to 4	10	3	30	6	4	66	16	7	43.7
4 to 6	16	5	31	4	2	50	20	7	35
6 to 8	9	1	11	20	6	30	29	7	24
8 to 10	30	0	0	20	3	15	50	3	6
10 to 12	57	1	1.7	20	0	0	77	1	1.3
12 to 14	102	2	1.9	37	6	15	139	8	5.7
14 to 16	163	7	4.2	25	3	12	188	10	5.3
16 to 18	95	5	5.2	16	3	19	111	8	7.1
18 and over	202	7	3.3	179	18	10	381	25	6.3
Total	698	41	5.8	332	47	14	1,030	88	8.5

Comparing our findings with those of other authors (Table 2) we find about the same figures as regards the percentage of positive reactions from the age of 8 years downward; but from 8 years upward there is a definite decrease of at least two-thirds in the number of persons showing positive reactions as compared with the results in other places. Assuming that the Schick reaction is an index of the susceptibility of individuals toward diphtherial infection, we must conclude that Filipino children are just as susceptible to diphtheria as are children in other places. Boys and girls of school age and adults, on the other hand, compared with individuals of the same age in Europe and America, are very much less susceptible to the disease.

The relatively low susceptibility of Filipinos as a whole cannot explain entirely the relatively rare incidence of diphtherial disease in the Philippines. Evidently there must be other factors that must be taken into consideration; for instance, climate and such other conditions as may also influence the relative infrequency in the Tropics of other diseases, such as serious respiratory disturbances, etc.

TABLE 2.—*Comparison of percentage of positive Schick reactions at various ages.*

Age.	Schick. (9)	Park, Zingher, and Serota. (6)	Moody. (5)	Kolmer and Moshage. (4)	Bundesen. (1)	Zingher. (11)	Wright (on Negroes. (10)	Johnson. (3)	Zingher (on soldiers). (12)	Gomez, Navarro, and Kapauan. (2)
Years.										
Under 1	10.2	40	33.3	12	28.3	--------	--------	76.6	--------	60
1 to 2	63.3	65	55.5	43	60	--------	--------	50	--------	66.6
2 to 4		66.8	64.5	66	50	32.2	--------	66.6	--------	43.7
4 to 6	49.5	50	56.5	58	45	25.7	--------	66.6	--------	35
6 to 8		35.1	44.3	57	34	21.8	--------	40	--------	24
8 to 10		26	39	24	36.6	22.6	--------	30	--------	6
10 to 12					39	21.4	--------		--------	1.3
12 to 14					39.6	17.7	--------	26	--------	5
14 to 16	--------	33	26.6	37.2	41.5	16.4	--------		--------	5
16 to 18	--------					--------	--------		--------	7.1
18 or over	--------					------	43		16.6	6.3

We desire to express to Dr. José Fabella, of the Public Welfare Board; Dr. Lorenzo C. Reyes, of the City of Manila; and Dr. Henry Pick, of Bilibid Prison, our appreciation of the courtesies extended to us during the performance of these tests in the institutions under their respective care.

REFERENCES

1. BUNDESEN, HERMAN N. The Schick reaction with a report of eight hundred cases. Journ. Am. Med. Assoc. **64** (1915) 1203.
2. GOMEZ, LIBORIO; KAPAUAN, AMANDO M.; and GAVINO, CATALINO. Diphtheria in the Philippine Islands. Philip. Journ. Sci. **17** (1920) 37.
3. JOHNSON, A. C. The results of the Schick test for diphtheria susceptibility in five hundred selected cases. Med. Record **94** (1918) 498.
4. KOLMER, J. A., and MOSHAGE, E. L. The Schick toxin reaction for immunity in diphtheria. Am. Journ. Dis. Childr. **9** (1915) 189.
5. MOODY, E. E. The intradermic diphtheria toxin test. Journ. Am. Med. Assoc. **64** (1915) 1206.
6. PARK, WILLIAM H.; ZINGHER, A.; and SEROTA, N. M. The Schick reaction and its practical application. Arch. Pediatrics **31** (1914) 481.
7. ROMER, PAUL H. Ueber den Nachweis sehr kleiner Mengen des Diphtheriegiftes. Zeitschr. f. Immunitätforsch. **3** (1909) orig. 208.
8. SCHICK, B. Spezifische Therapie der Diphtherie. Centralbl. f. Bakt. **57**[1] (1913) Ref. 16.
9. SCHICK, B. Die Diphtherietoxin-Hautreaktion des Menschen als Vorprobe der prophylaktischen Diphtherieheilseruminjektion. Münchener med. Wochenschr. **60** (1913) 2608.
10. WRIGHT, L. T. The Schick's test with especial reference to the Negro. Journ. Infect. Dis. **21** (1917) 265.
11. ZINGHER, A. Methods of using diphtheria toxin in the Schick's test and of controlling the reaction. Am. Journ. Dis. Childr. **11** (1916) 264.
12. ZINGHER, A. Interpretation of the Schick reaction in recruits for the National Army. Journ. Am. Med. Assoc. **70** (1918) 227.

ILLUSTRATIONS

[Photographs by E. Cortes.]

PLATE 1

FIG. 1. Typical Schick reaction, three days after injection. L.M., Filipino, female, 6 years old. Right arm (upper) injected with 0.02 minimum lethal dose toxin and left arm (lower) injected with a mixture of 0.02 minimum lethal dose toxin and 0.2 unit of antitoxin. Photographed on January 17, 1920.

2. The right arm of the case shown in fig. 1, thirteen days after the injection, showing especially the scaling after a positive Schick reaction. The injection was performed on January 14, 1920, and the photograph was taken on January 27, 1920.

PLATE 2

FIG. 1. Bleb formation in Schick reaction, three days after injection. Above is J.M., Filipino, male, 11 years old and below is D.Y., Filipino, female, 14 years old. Photographed on October 20, 1920.

2. Pigmentation after bleb formation in Schick reaction. Same cases as fig. 1, three months after injection. Injected October 17, 1919, and this photograph was taken on January 17, 1920.

PLATE 3

FIG. 1. Repeated Schick test. G.S., Filipino, male, 39 years old, photographed on January 27, 1920. The dark area toward the elbow is the pigmentation that was left by a previous positive Schick test (October 9, 1919). The small dark area toward the wrist shows the appearance of the second reaction four days after the injection.

2. Typical Schick reaction. C.G., Filipino, female, 37 years old. Right arm injected with 0.02 minimum lethal dose unheated toxin and left arm with 0.02 minimum lethal dose toxin heated to 75° C. for five minutes the first time and ten minutes the second time. First test injected on October 17 and second test on October 25, 1921. Photographed on October 28, 1921. Notice the pigmentation (the site nearer the elbow) that remained eleven days after the first injection, and the beginning desquamation of the skin (the site farther from the elbow) three days after the second injection. The control arm shows no marks whatever, after receiving toxin heated for five minutes in the first test and for ten minutes in the second test.

PLATE 4

FIG. 1. Pseudoreaction. Right forearm of F.A., Filipino, female, 12 years old. Injected 0.02 minimum lethal dose diphtheria toxin intracutaneously on December 18, 1919. Photograph taken twenty-eight hours after the injection.

2. Pseudoreaction three days and eleven days after injection. B.M., Filipino, female, 24 years old. Right forearm injected with 0.02 minimum lethal dose unheated toxin. Left forearm injected on the outer side with the same amount of toxin heated to 75° C. for five minutes, and on the inner side with toxin heated to 75° C. for ten minutes. Smaller marks are due to pigmentation (on site near the elbow on the right forearm and on the outer side on the left forearm), which remained after the first test October 17, 1921; larger marks on the farther side from the elbow on the right forearm and on the inner side on the left forearm produced by inflammation from the second test October 25, 1921. Photographed on October 28, 1921.

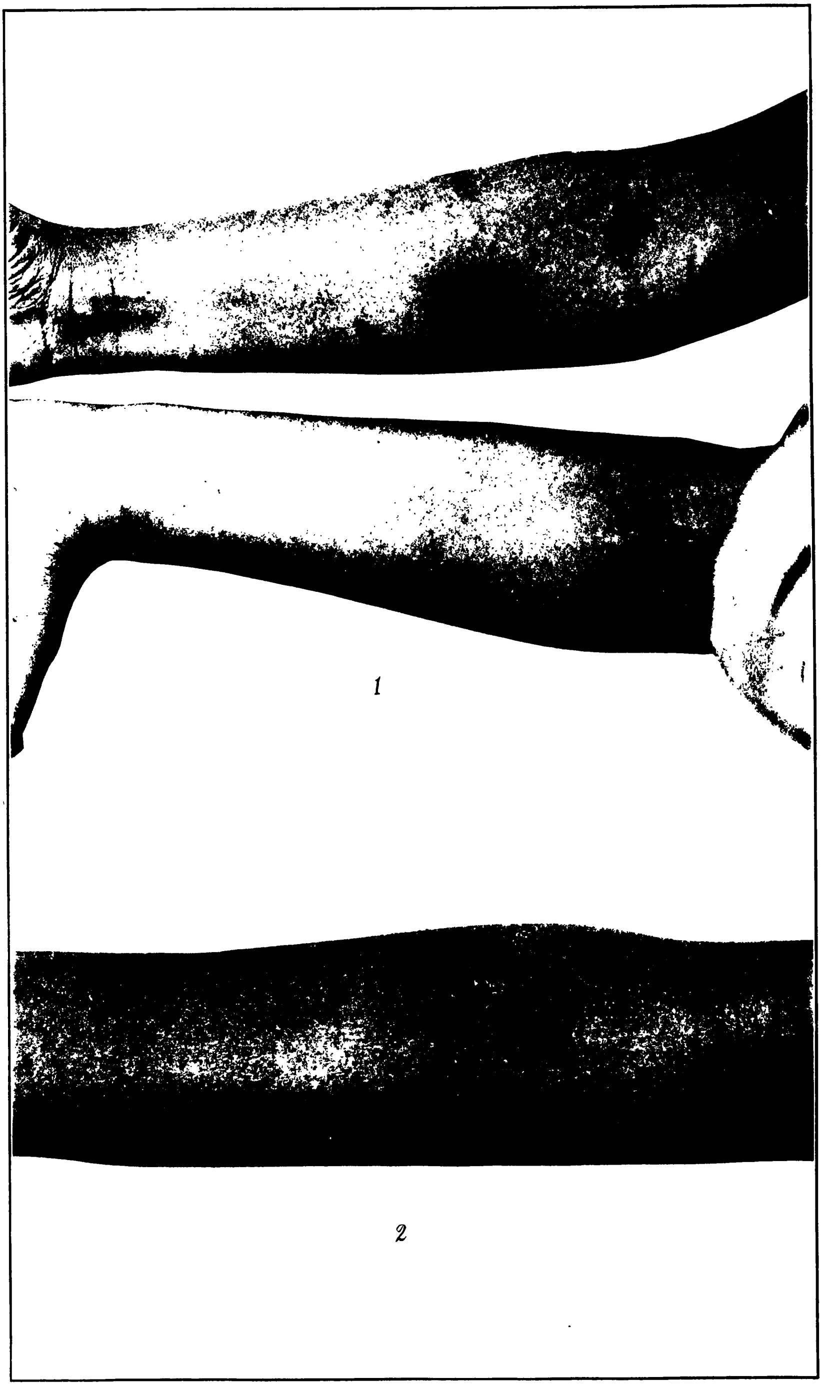

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PLATE 1.

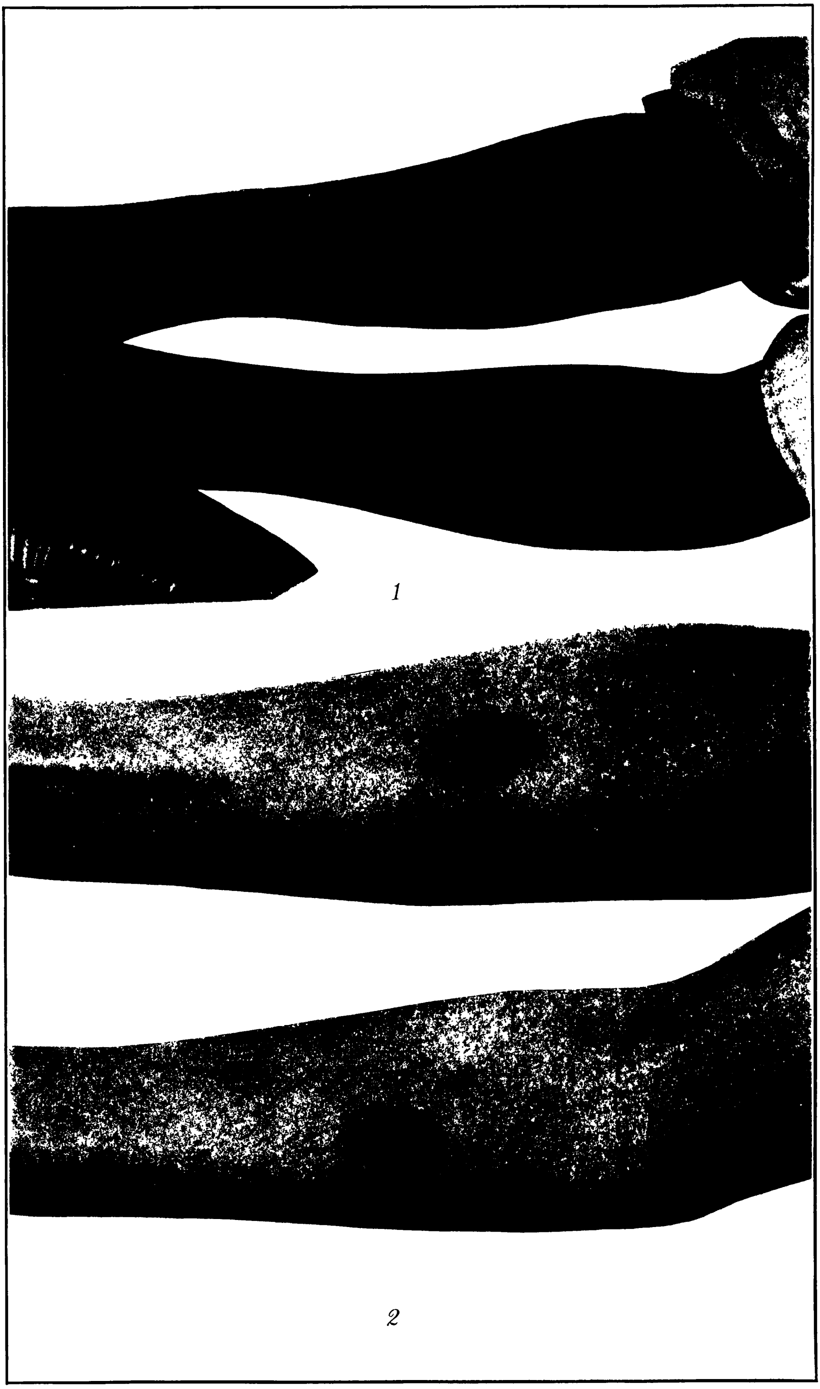

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PLATE 2.

1

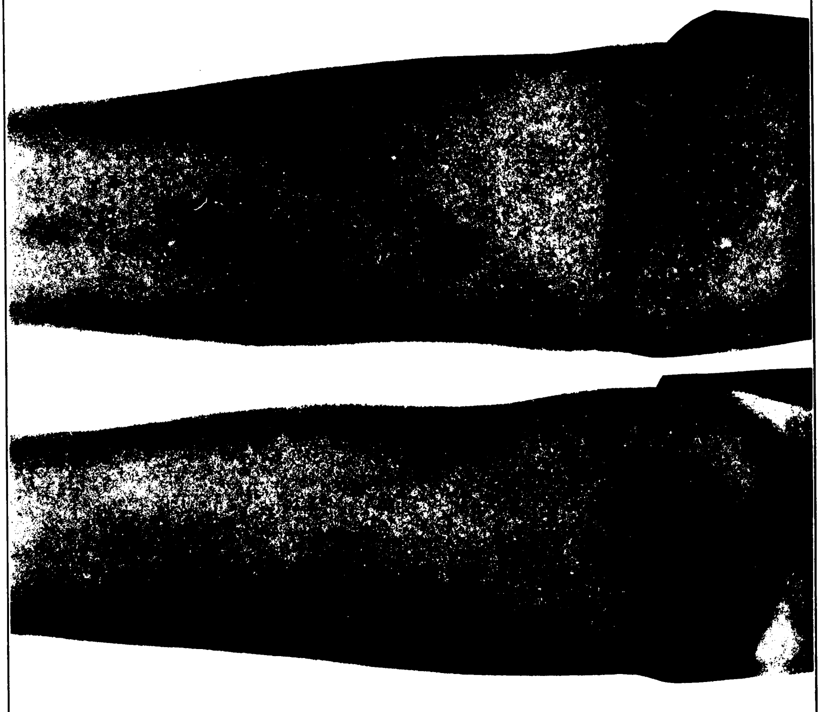

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PLATE 3.

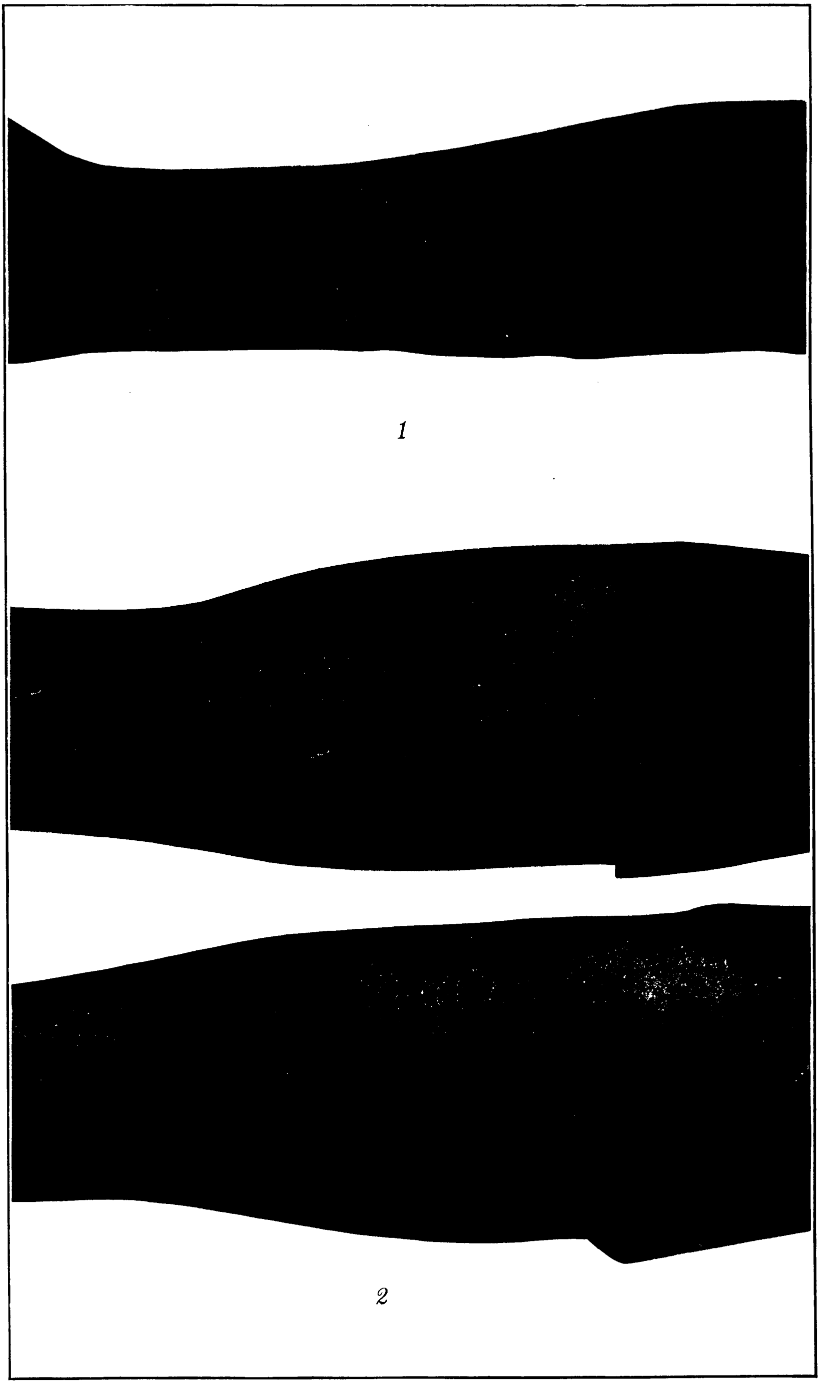

PLATE 4.

RELATION OF THE AGE OF CITRUS TISSUES TO THE SUSCEPTIBILITY TO CITRUS CANKER

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FOUR PLATES AND ONE TEXT FIGURE

INTRODUCTION

The writer has previously shown that there is an increase in resistance to the plant disease citrus canker with the advance in maturity of citrus trees.[1] In the present paper experiments are presented which indicate that local tissues of citrus plants, both foliage and fruit, also increase in resistance as they approach maturity.

The purpose of the experiments was to inoculate fruits of different degrees of maturity, using identical cultures and maintaining identical environmental conditions, and measuring the amounts of canker resulting at such different stages of maturity. Similar experiments were carried out on foliage.

EXPERIMENTAL RESULTS

Preliminary experiments were begun on fruits of the pineapple orange (*Citrus sinensis*) in the Philippines. The pineapple orange variety is of Florida origin and grown to some extent commercially in that state. Fruits on vigorous, actively growing orchard trees were selected in varying stages of maturity as measured by their size. The fruits were inoculated from the same infusion of cultures of the citrus-canker organism, *Pseudomonas citri,* and maintained under identical environmental conditions favorable for canker formation. The results are shown in Table 1.

The data in Table 1 show that there is a very considerable susceptiblity for fruits of a small diameter, while large fruits approaching maturity were but slightly affected by canker, if at

[1] Lee, H. Atherton, The increase in resistance to citrus canker with the advance in maturity of citrus trees, Phytopathology 11 (1921) 70.

all. In other words, apparently there was a lessening of susceptibility with increasing maturity. The experiment was repeated on fruits of the Valencia orange, using the same methods.

TABLE 1.—*Results of inoculation with Pseudomonas citri by twenty needle punctures on pineapple orange fruits of various degrees of maturity, as measured by their size.*

[Date of inoculation May 25, 1918; date of observation of results June 3, 1918.]

Fruit.			Results; infections.	
No.	Diameter.	Condition.	At punctures.	Not at punctures.
	mm.		*Per cent.*	*Number.*
1	19		90	78
2	19		100	([a])
3	25		100	41
4	25		100	18
5	29		100	10
6	32		100	8
7	32		100	16
8	32		80	3
9	32		90	6
10	32		90	5
11	32		80	1
12	44		80	1
13	50		50	0
14	50		80	0
15	57	Still green	[b] 0	0
16	57	do	5	0
17	57	do	[b] 0	0
18	57	do	[b] 0	0
19	57	do	60	0
20	63	do	[b] 0	0
21	69	do	0	0

[a] Numerous.

[b] In these cases a reaction was produced as indicated by a yellow halo around the punctures; nevertheless no excrescence was formed, and it could not be said that cankers were present.

The results shown in Table 2 for the Valencia orange are in entire agreement with those shown in Table 1 on the pineapple orange. Plate 1 shows the difference in the results obtained from fruits of different degrees of maturity.

The experiments were then continued in Nagasaki Prefecture, Japan, on fruits of the Washington navel orange. In this case, however, it was possible to carry out the experiments throughout the whole growing season. Fruits were inoculated at the time of the dropping of the petals in late May and early June, and thereafter at different periods during their development toward maturity. It was thus possible to use fruits of a known

TABLE 2.—*Results of inoculation with Pseudomonas citri by twenty needle punctures on Valencia orange fruits of various degrees of maturity, as measured by their size.*

[Date of inoculation June 4, 1918; date of observation June 22, 1918.]

Fruit.			Results; infections.	
No.	Diameter.	Condition.	At punctures.	Not at punctures.
	mm		*Per cent.*	*Number.*
1	25		90	10
2	25		100	75
3	25		100	40
4	48		45	80
5	50	Approaching maturity	55	0
6	50	do	0	1
7	50	do	0	0
8	50	do	0	0
9	52	do	0	0
10	52	do	0	0

TABLE 3.—*Results of inoculation with Pseudomonas citri on Washington navel orange fruits of various degrees of maturity.*

Fruit.			Needle punctures.	Infections.	
No.	Age.[a]	Diameter.		At punctures.	Not at punctures.
	Days.	*mm.*		*Per cent.*	*Number.*
1	2	8.0	0		Fruit dropped.
2	2	6.5	0		Do.
3	2	9.5	0		Do.
4	2	8.0	0		Do.
5	2	8.0	0		Mass of cankers.
6	2	11.0	0		Fruit dropped.
7	2	8.0	0		Mass of cankers.
8	2	8.0	0		Fruit dropped.
9	2	6.5	0		Do.
10	2	8.0	0		Do.
11	2	9.5	10		Do.
12	2	11.0	10	100	150+
13	2	8.0	10		Fruit dropped.
14	2	11.0	10		Do.
15	2	8.0	10		Do.
16	2	8.0	10		Do.
17	2	8.0	10		Do.
18	2	8.0	10	100	Mass of cankers.
19	2	6.5	10		Fruit dropped.
20	2	6.5	10		Do.
21	15	16.0	0		Do.
22	15	11.0	0		Do.

[a] It is difficult to determine practically the period at which the ovary of the flower becomes a fruit; in this case, fruits 1 to 20 were inoculated but one or two days after the petals had dropped.

TABLE 3.—*Results of inoculation with Pseudomonas citri on Washington navel orange fruits of various degrees of maturity*—Continued.

Fruit.			Needle punctures.	Infections.	
No.	Age.[a]	Diameter.		At punctures.	Not at punctures.
	Days.	*mm.*		*Per cent.*	*Number.*
23	15	9.5	0		Fruit dropped.
24	15	14.5	0		100+
25	15	16.0	0		Fruit dropped.
26	15	14.5	0		100+
27	15	13.0	0		Fruit dropped.
28	15	19.0	0		Do.
29	15	14.5	0		Do.
30	15	11.0	0		100+
31	30	13.0	0		300+
32	30	24.0	0		400+
33	30	19.0	0		Mass of cankers.
34	30	13.0	0		Do.
35	30	22.5	0		Do.
36	30	16.0	0		Do.
37	30	22.5	0		Do.
38	30	17.5	0		Do.
39	30	14.5	0		Fruit dropped.
40	30	21.0	0		Mass of cankers.
41	44	38.0	0		200+
42	44	28.5	0		49
43	44	32.0	0		70
44	44	22.5	0		Fruit dropped.
45	44	35.0	0		100+
46	44	25.5	0		Fruit dropped.
47	44	28.5	0		Mass of cankers.
48	44	14.5	0		Do.
49	44	25.5	0		Do.
50	44	28.5	0		Do.
51	55	38.0	0		100+
52	55	41.5	0		100+
53	55	44.5	0		33
54	55	35.0	0		Mass of cankers.
55	55	41.5	0		50
56	55	44.5	20	100	100+
57	55	35.0	20	100	Mass of cankers.
58	55	43.0	20	100	34
59	55	41.5	20	100	33
60	55	38.1	20	100	52
61	86	50.0	0		1
62	86	57.0	0		None.
63	86	44.0	0		2
64	86	57.0	0		4
65	86	50.0	0		14
66	86	48.0	20	80	1
67	86	50.0	20	40	7

[a] It is difficult to determine practically the period at which the ovary of the flower becomes a fruit; in this case, fruits 1 to 20 were inoculated but one or two days after the petals had dropped.

TABLE 3.—*Results of inoculation with Pseudomonas citri on Washington navel orange fruits of various degrees of maturity*—Continued.

Fruit.			Needle punctures.	Infections.	
No.	Age.[a]	Diameter.		At punctures.	Not at punctures.
	Days.	*mm.*		*Per cent.*	*Number.*
68	86	57.0	20	90	4
69	86	50.0	20	90	6
70	86	48.0	20	95	None.
71	101	60.0	20	100	Do.
72	101	55.0	20	100	4
73	101	50.0	20	100	2
74	101	57.0	20	100	None.
75	101	52.0	20	100	Do.
76	101	63.0	0	----------	Do.
77	101	66.0	0	----------	Do.
78	101	54.0	0	----------	Do.
79	101	54.0	0	----------	Do.
80	101	50.0	0	----------	Dc.
81	117	46.0	20	0	Do.
82	117	50.0	20	([b])	Do.
83	117	50.0	20	[c]25	Do.
84	117	48.0	20	[c]25	Do.
85	117	50.0	20	[c]40	Do.
86	117	52.0	20	[c]40	Do.
87	117	48.0	20	[c]25	Do.
88	117	50.0	20	[c]60	Do.
89	117	48.0	20	[c]60	Do.
90	117	48.0	20	[c]60	Do.
91	130	69.0	20	0	Do.
92	130	66.0	20	0	Do.
93	130	66.0	20	0	Do.
94	130	69.0	20	0	Do.
95	130	69.0	20	[c]4	Do.
96	130	76.0	0	0	Do.
97	130	63.0	0	0	Do.
98	130	69.0	0	0	Do.
99	130	63.0	0	0	Do.
100	130	66.0	0	0	Do.

[a] It is difficult to determine practically the period at which the ovary of the flower becomes a fruit; in this case, fruits 1 to 20 were inoculated but one or two days after the petals had dropped.

[b] Fruit lost.

[c] Although these punctures are recorded as yielding positive results, nevertheless the only reaction obtained was a yellow discoloration without actual canker formation. From an orange grower's viewpoint no canker resulted.

age as well as to approximate their stages of maturity by their sizes. Throughout the season similar technic was used for the inoculation, and the inoculum was always obtained from 7- to 10-day potato cylinder cultures. All inoculations were maintained under identical environmental conditions. The results are recorded in Table 3.

The data contained in Table 3 rather definitely indicate an increasing resistance of fruit tissues as they matured. It may be stated even more strongly that the tissues became immune with maturity. Some of the striking results obtained are shown in Plates 1, 2, and 3.

Paralleling the experiments upon the Washington navel variety, tests were made upon fruits of the Ikiriki strain of the Unshiu (Satsuma) orange (*Citrus nobilis* var. *unshiu*.) The petals of the blossoms of this variety drop at about the same time as those of the Washington navel orange, although the flowers of the Unshiu orange sometimes extend a week or ten days later

TABLE 4.—*Results of inoculation with Pseudomonas citri on Unshiu orange fruits of various degrees of maturity.*

Fruit.			Needle punctures.	Infections.	
No.	Age.[a]	Diameter.		At punctures.	Not at punctures.
	Days.	*mm.*		*Per cent.*	*Number.*
1	2	6.4	10	----------	Fruit dropped.
2	2	4.8	10	----------	Do.
3	2	8.0	10	10	
4	2	11.2	10	30	
5	2	6.4	10	5	
6	2	8.0	10	----------	Fruit dropped.
7	2	9.6	10	75	
8	2	12.8	10	----------	Fruit dropped.
9	2	9.6	10	0	
10	2	8.0	10	5	
11	2	12.8	0	----------	11
12	2	9.6	0	----------	Numerous.[b]
13	2	8.0	0	----------	11
14	2	9.6	0	----------	Fruit dropped.
15	2	9.6	0	----------	9
16	2	12.8	0	----------	18
17	2	12.8	0	----------	3
18	2	8.0	0	----------	5
19	2	8.0	0	----------	Fruit dropped.
20	2	9.6	0	----------	Do.
21	2	8.0	0	----------	None.
22	2	8.0	0	----------	Fruit dropped.
23	2	6.4	0	----------	Do.
24	2	8.0	0	----------	2
25	2	8.0	0	----------	6
26	2	8.0	0	----------	8
27	2	8.0	0	----------	4

[a] As with the Washington navel fruits, it was very difficult to determine for practical purposes the stage at which the ovary of the flower became a fruit. In the present case fruits 1 to 20 were inoculated but one or two days after the flower petals had fallen.

[b] The term numerous was used only in the case of an observation of a fruit in which the cankers were so many as to form a mass of lesions difficult to identify strictly and count definitely.

TABLE 4.—*Results of inoculation with Pseudomonas citri on Unshiu orange fruits of various degrees of maturity*—Continued.

Fruit.			Needle punctures.	Infections.	
No.	Age.[a]	Diameter.		At punctures.	Not at punctures.
	Days.	*mm.*		*Per cent.*	*Number.*
28	2	6.4	0		Fruit dropped.
29	2	11.2	0		11
30	2	9.6	0		18
31	24	16.0	10		Fruit dropped.
32	24	16.0	10		Do.
33	24	19.2	10	100	Numerous.
34	24	11.2	10		Fruit dropped.
35	24	16.0	10		Do.
36	24	20.8	10	100	Numerous.
37	24	22.4	10		Fruit dropped.
38	24	28.8	10	100	Numerous.
39	24	12.8	10		Fruit dropped.
40	24	19.2	10		Do.
41	24	19.2	0		Do.
42	24	12.8	0		Do.
43	24	9.6	0		Numerous.
44	24	24.0	0		Fruit dropped.
45	24	16.0	0		Numerous.
46	24	22.4	0		Do.
47	24	22.4	0		Do.
48	24	20.8	0		Do.
49	24	22.4	0		Do.
50	24	16.0	0		Do.
51	54	35.0	0		45
52	54	31.8	0		5
53	54	33.4	0		5
54	54	35.0	0		Numerous.
55	54	31.8	0		28
56	54	36.6	20	30	3
57	54	35.0	20	25	None.
58	54	44.2	20	15	8
59	54	30.2	20	30	8
60	54	31.8	20	0	3
61	98	50.8	20	0	None.
62	98	47.8	20	(c)	
63	98	44.2	20	0	None.
64	98	47.8	20	0	Do.
65	98	50.8	20	0	Do.
66	98	33.8	0		Do.
67	98	47.8	0		Do.
68	98	57.2	0		Do.
69	98	47.8	0		Do.
70	98	47.8	0		Do.

[a] As with the Washington navel fruits, it was very difficult to determine for practical purposes the stage at which the ovary of the flower became a fruit. In the present case fruits 1 to 20 were inoculated but one or two days after the flower petals had fallen.

[c] Fruit lost.

into the season than the navel orange, in this district. These experiments were also carried on in Nagasaki Prefecture, Japan. The technic, sources of inoculum, and maintenance of inoculated fruits were the same as for the Washington navel fruit inoculations. The results are recorded in Table 4.

Stomatal infections obtained on the Unshiu orange fruits are shown in Plate 4. It is apparent from the results in Table 4 that there is a period during which Ikiriki Unshiu orange fruits have a considerable degree of susceptibility. Similar experiments were carried on upon the Owari Unshiu orange, the Zairai Unshiu orange, and the Wase Unshiu orange, in which the susceptibility varied but little, but in which the period of susceptibility was somewhat shorter than in the case of the Ikiriki orange, usually not more than seventy days. There is apparently a much shorter period of susceptibility in the case of these varieties than is the case with the Washington navel orange. The total period of possible infection is not more than ninety-eight days for the Unshiu oranges, as compared with one hundred fifteen to one hundred twenty days for the Washington navel orange.

There are further but less systematic data which point to a longer period of susceptibility for fruit tissues of the grapefruit [*Citrus maxima* (*decumana*)] than for either the Washington navel orange or the Unshiu orange. The differences in length of the periods of susceptibility of these species is well illustrated in the graph, fig. 1.

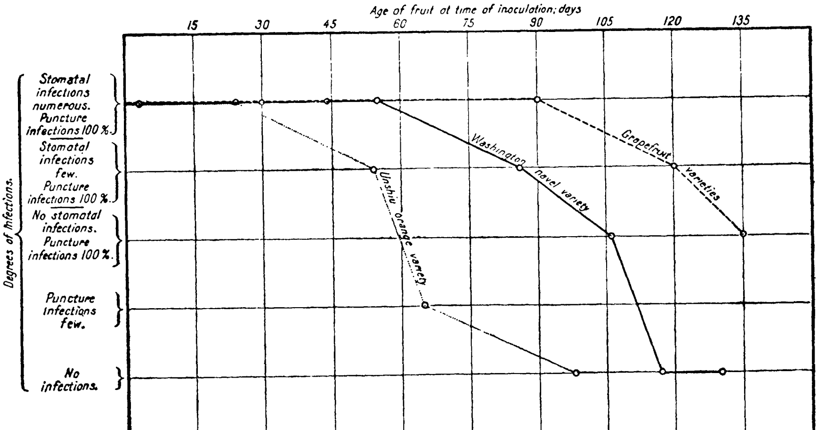


FIG. 1. Graphs showing the differences in lengths of periods of susceptibility of three commercial citrus varieties. The line of the period of susceptibility of the grapefruit varieties is not based on actual ages of the fruits, but the estimated ages judged by their sizes.

It is of less immediate practical importance, and much more difficult, to obtain exact data on the increase in resistance with advance in maturity of foliage tissues. The difficulty is, in the main, in obtaining a criterion of the degree of maturity of a leaf.

The data obtained have been from Washington navel leaves classed as (*a*) young, actively growing; (*b*) size fully developed but leaf still glossy, and the color only slightly deepened; and (*c*) fully matured and hardened leaves. The experimental results from similar infusions with identical technic and maintenance of inoculations indicate that, as the leaves become fully developed in size, the amounts of infection obtained, both with needle punctures and as stomatal infections, are very much lessened. Leaves become entirely resistant when they reach the size of maturity.

DISCUSSION OF RESULTS

The results obtained from the foregoing experiments apparently would warrant the statement, in conclusion, that the susceptibility of fruit and foliage tissues decreases with their advance toward maturity.

These results and conclusions are very intimately connected with field practices in preventing citrus canker. As the writer has pointed out in a paper now in press the problem of canker control on the moderately susceptible hosts, from the growers' viewpoint, may be narrowed to the prevention of fruit infections. The fruits of the Washington navel orange form in late May or June in western Japan. The period of susceptibility for such fruits in this district, as shown in Table 3, extends over possibly eighty-five days, during which stomatal infections are probable. After this age the fruits are but slightly susceptible to stomatal infection, although infections at wounds and injuries may take place in a large percentage of the chances until one hundred ten to one hundred twenty days. Thereafter, in this district, fruits of this variety are, for all practical purposes, immune. It would follow that preventive methods may largely be confined to the period of June, July, and August in the district where the results here reported were obtained.

The data on the susceptibility of the Unshiu orange are of less interest in local canker prevention because lesions upon this fruit are small, scarcely noticeable and, as observed in the seasons of 1918 and 1919, not at all common in Japan. Canker upon fruits of this variety, therefore, is almost negligible from the Japanese growers' viewpoint.

ILLUSTRATIONS

PLATE 1

FIG. 1. Fruits of the Valencia orange; above, inoculated with *Pseudomonas citri* and twenty needle punctures giving 100 per cent positive results; below, fruits more nearly mature, inoculated by the same methods and the same culture, giving entirely negative results.

2. Fruits of the Washington navel orange inoculated with *Pseudomonas citri* when 44 days old, showing numerous stomatal infections and the stunted size of the fruits.

PLATE 2

FIG. 1. A fruit of the Washington navel orange inoculated with *Pseudomonas citri* when 55 days old, showing stomatal infections as well as 100 per cent infection at needle punctures.

2. A fruit of the Washington navel orange inoculated with *Pseudomonas citri* when 86 days old, showing no stomatal infections but 100 per cent infection at needle punctures.

PLATE 3

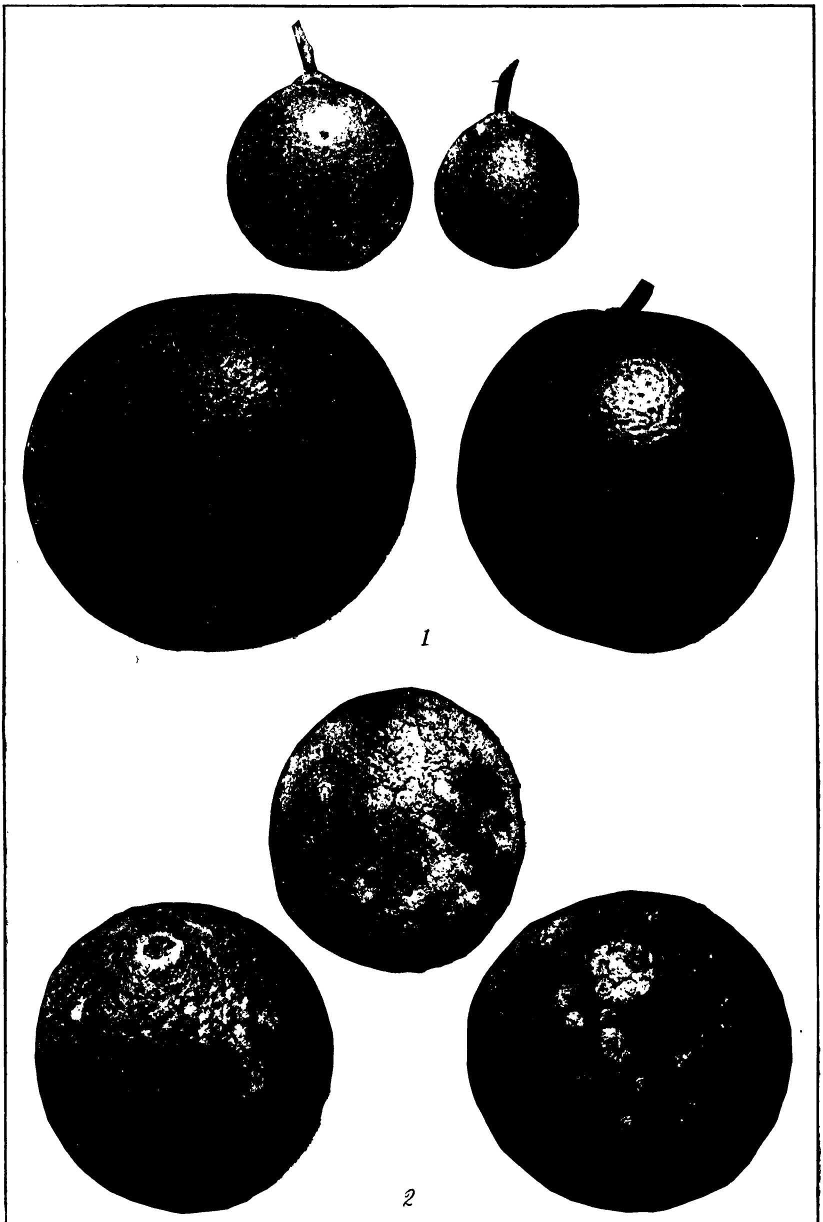
Fruits of the Washington navel orange, each inoculated with *Pseudomonas citri* and twenty needle punctures when 130 days old, showing the entirely negative results.

PLATE 4

Fruits of the Ikiriki Unshiu (Satsuma) orange inoculated without needle punctures when 40 days old, showing the numerous stomatal infections and their atypical character.

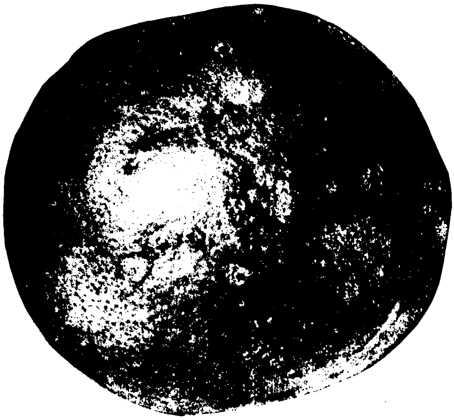
TEXT FIGURE

FIG. 1. Graphs showing the differences in lengths of periods of susceptibility of three commercial citrus varieties.



Oranges inoculated with Pseudomonas citri. Fig. 1. Valencia oranges, above giving 100 per cent positive results; below, more nearly mature fruits giving negative results. 2. Washington navel oranges inoculated when 44 days old, showing stomatal infections and stunted size.

PLATE 1.



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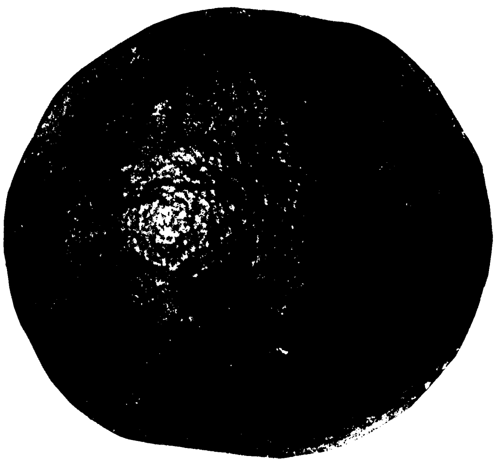
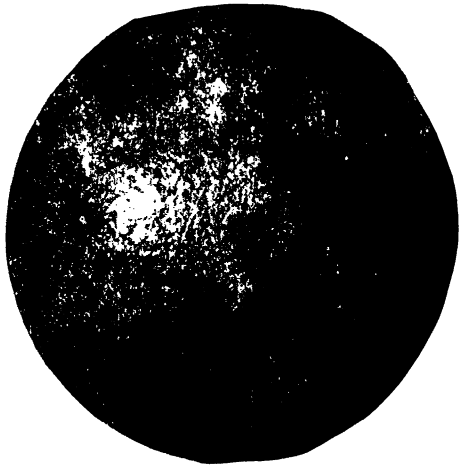


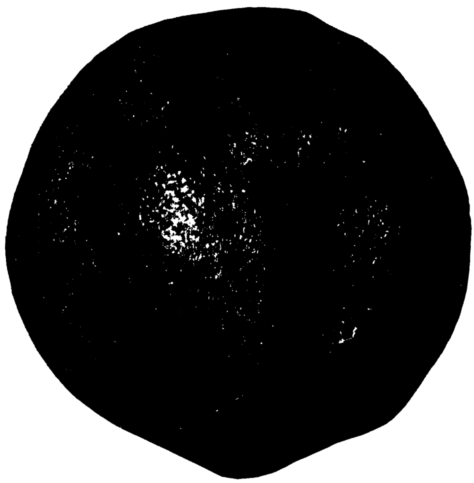
2

Washington navel oranges inoculated with Pseudomonas citri. Fig. 1. A fruit 55 days old, showing stomatal infections and 100 per cent infection at needle punctures. 2. A fruit 85 days old, showing no stomatal infection but 100 per cent infection at needle punctures.

PLATE 2.



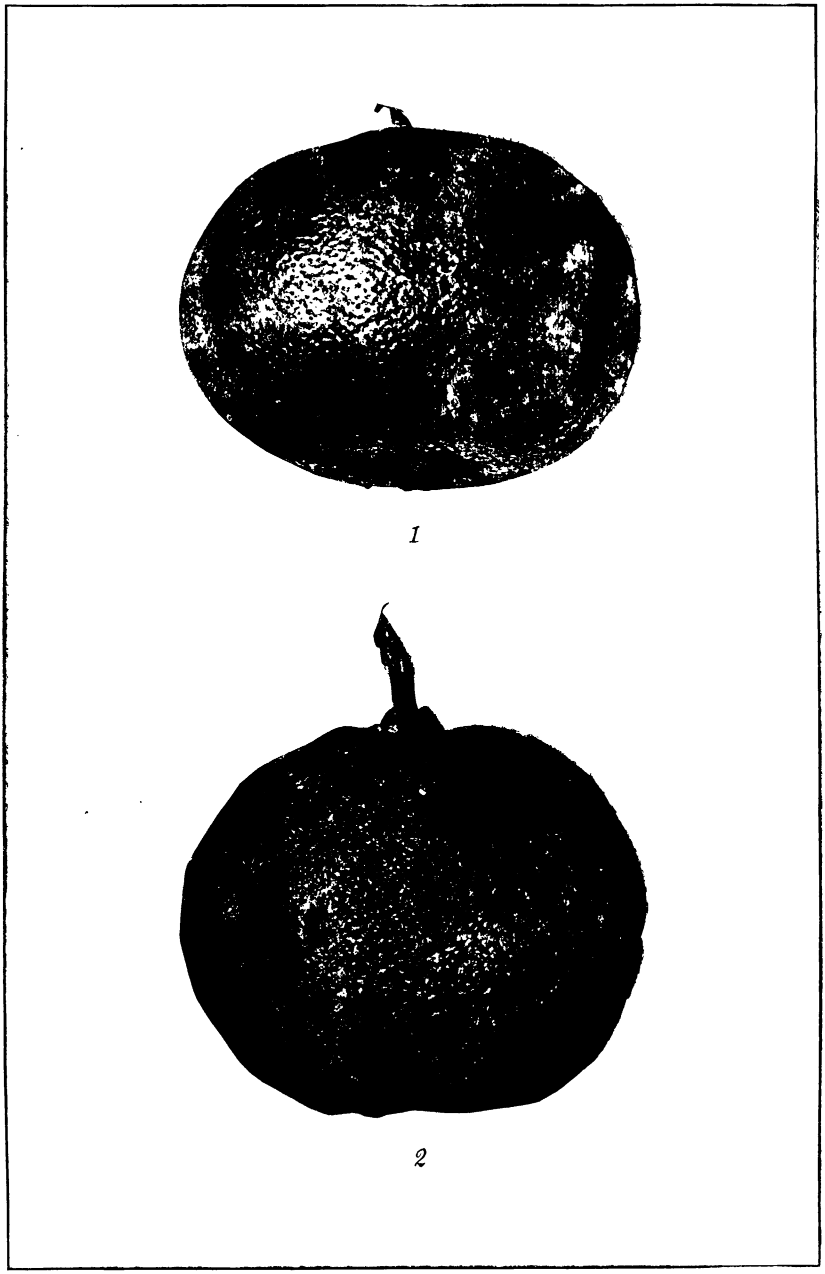
1



2

Washington navel oranges, each inoculated with Pseudomonas citri and twenty needle punctures when 130 days old, showing the entirely negative results.

PLATE 3.



Ikiriki Unshiu (Satsuma) oranges inoculated without needle punctures when 40 days old, showing the numerous stomatal infections and their atypical character.

PLATE 4.

A MOUNTED SPECIMEN OF THE MONKEY-EATING EAGLE (PITHECOPHAGA JEFFERYI) OF THE PHILIPPINES

By R. W. SHUFELDT
Washington, D. C.

ONE PLATE

Being engaged at the present time upon a brief life history of the gannets (Sulidæ) I communicated with Mr. J. H. Gurney, the author of the splendid volume on those birds, to ascertain whether he could furnish me with a few facts in regard to them that may not have appeared in his book. To my great delight the request brought me far more than I anticipated, as my readers will appreciate later. With the material Mr. Gurney was so good as to send me, he generously inclosed a fine photograph of the monkey-eating eagle of the Philippines, *Pithecophaga jefferyi* Grant. This picture is of the mounted specimen that forms a part of the series of the birds of prey in the Norwich Museum, at Norwich, England, of which institution Mr. Gurney is director.

Some time ago I published a full account of the skeleton of this species,[1] so it is with exceptional pleasure that I am enabled to offer here such an excellent figure of the bird as the Norwich Museum specimen furnishes. Comparatively few among us have seen specimens of this species, and still fewer have enjoyed studying this giant among the eagles in nature; so I feel pretty sure that the illustration here reproduced will be appreciated.

This eagle is a rather light-colored species; its bill is black and its feet are a medium shade of chrome or pale orange, varying to yellow in some specimens. Its plumage is white, cream, pale tan, and different browns; the irides golden yellow.

McGregor has published some interesting notes on specimens of this remarkable eagle.[2]

[1] Philip. Journ. Sci. **15** (1919) 31–55.

[2] Philip. Journ. Sci. § D **13** (1918) 14; **19** (1921) 696.

ILLUSTRATION

PLATE 1. *Pithecophaga jefferyi* Grant, from a photograph of a mounted specimen in the Norwich Museum, Norwich, England.

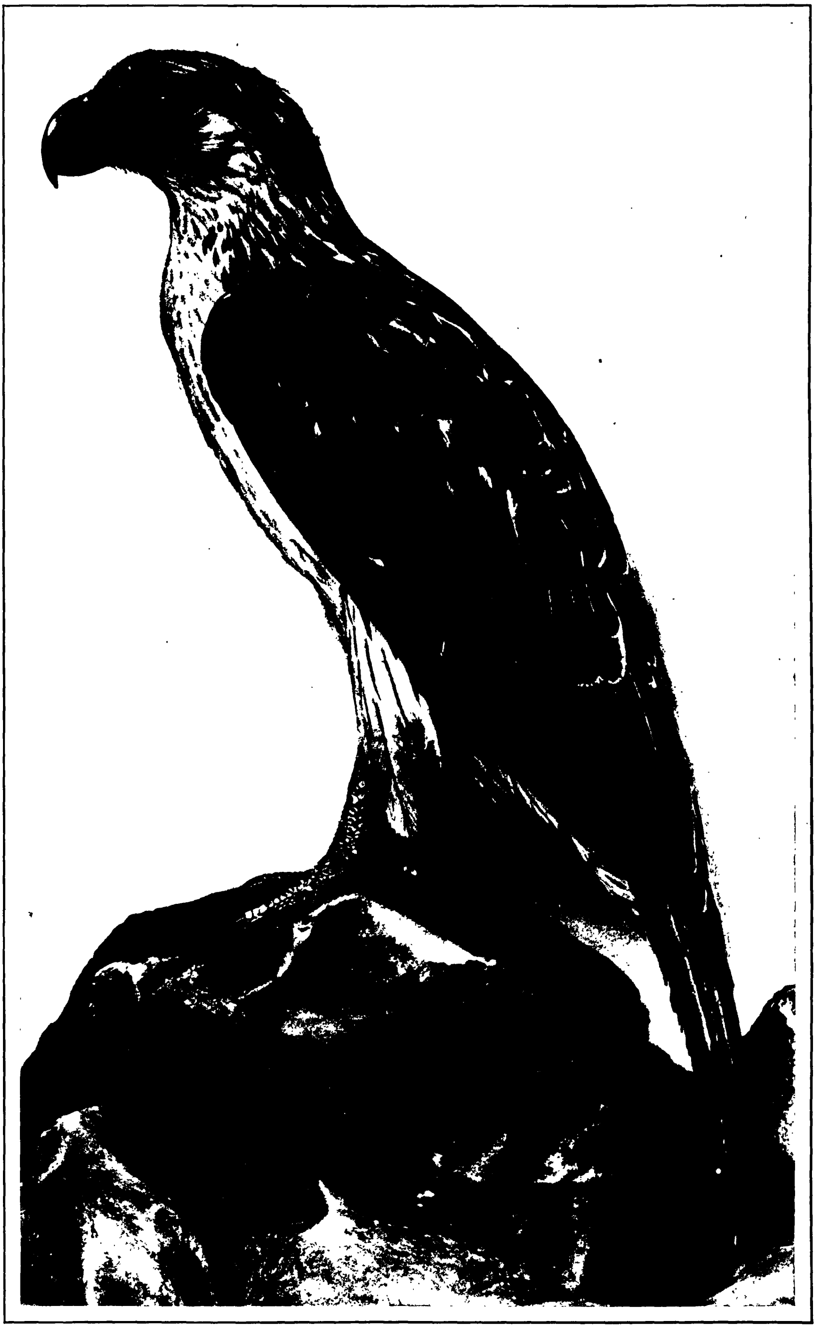


PLATE 1. PITHECOPHAGA JEFFERYI GRANT, FROM A PHOTOGRAPH OF A MOUNTED SPECIMEN IN THE NORWICH MUSEUM, NORWICH, ENGLAND.

THREE NEW SPECIES OF DERBIDÆ (HOMOPTERA)

By F. Muir

Of the Hawaiian Sugar Planters' Experiment Station, Honolulu

FOUR TEXT FIGURES

Zoraida kalshoveni sp. nov. Figs. 1 and 2.

Male.—Length, 3.6 millimeters; tegmen, 10; wing, 1.

Subcosta obscure, lying beneath radius; subcostal cell widened at apex with a round, raised callus in the middle; radial cell very narrow up to callus.

Anal segment large, anus about a third from apex, narrowed slightly on basal half, apex narrowed, truncate; lateral margins of pygofer angularly produced, medioventral margin angularly produced, genital styles long, narrow on basal half, apical half considerably widened, outer margin of apical half curved over, the inner margin with a curved spine about the middle.

FIG. 1. *Zoraida kalshoveni* sp. nov.; male genitalia, lateral view.

Vertex and face yellow; clypeus light brown, darker between the carinæ; pronotum light on sides, darker in the middle; mesonotum light brown; legs light brown; abdomen brown, yellow near base; genital styles darker. Tegmina hyaline; costal, subcostal, and radial cells red, the callus in apex of radial cell fuscous, shining; a brown band from media to clavus over the basal portion of the fork of cubitus including the apical half of basal cell, the veins in this fuscous area yellow; veins light brown. Wings hyaline, slightly fuscous.

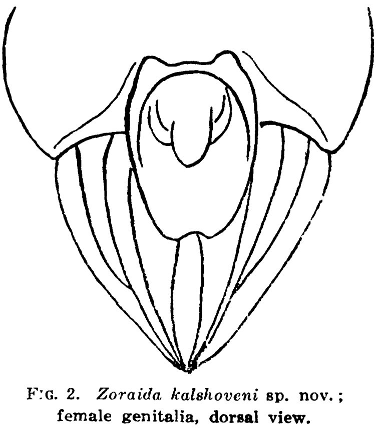


FIG. 2. *Zoraida kalshoveni* sp. nov.; female genitalia, dorsal view.

Female.—Length, 5.3 millimeters; tegmen, 12.3; wing, 1.2. Pregenital plate angularly produced from sides to middle. Anal segment small, reaching about halfway to apex of styles, sides slightly curved, apex slightly emarginate. In coloration similar to male.

SINGAPORE (*C. F. Baker*), 1 male and 1 female. JAVA, Bodjanegoro (*L. Kalshoven*), 1 female.

Zoraida bakeri sp. nov. Fig. 3.

Female.—Length, 5.3 millimeters; tegmen, 10; wing, 1.

In general build and venation this species is similar to *Z. kalshoveni*.

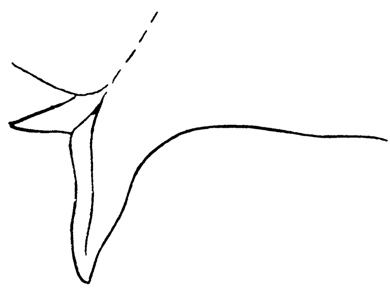


FIG. 3. *Zoraida bakeri* sp. nov.; female pregenital plate, lateral view.

Mesonotum light brown, darker over basal portion. The anal segment is longer, broadest on basal third, gradually narrowed to the truncate apex. The pregenital plate in lateral view turned ventrad at a right angle, in full view the apex is rounded.

BORNEO, Sandakan (*C. F. Baker, 9533*), 1 female.

Zoraida mcgregori sp. nov.

Zoraida sinuosa (Boheman) ? MUIR, Philip. Journ. Sci. § D 12 (1917) 84, Pl. 1, fig. 14.

In the above-cited paper I allowed the Philippine specimens to stand under *sinuosa* until I could examine specimens from West Africa. I have now been able to do this and find that they are quite distinct; so I now name the Philippine species after Mr. R. C. McGregor, of the Bureau of Science, who some time ago forwarded me specimens for identification. The type is a specimen from Malinao, Tayabas, and the paratypes, the specimens mentioned in the previous paper as well as other specimens subsequently received, from the Philippines.

The genitalia have been described and figured previously.

Male.—Length, 4 millimeters; tegmen, 10; wing, 5.

Antennæ longer than face, cylindrical, stramineous or light brown; often white with waxy secretion over mesoscutellum and metanotum and along the middle of dorsum of abdomen; genitalia red. Tegmina hyaline, veins red or brown; fuscous over costal, subcostal, and radial cells in basal median cell,

running into median cells at base of sectors; a faint fuscous mark at apex of apical cells; apical veins brown to apex.

Female.—Length, 4 millimeters; tegmen, 11; wing, 5. Female similar in color to male. The tegmina have a slightly opaque, milky appearance.

Zoraida sinuosa (Boheman). Fig. 4.

I herewith publish a figure of *Zoraida sinuosa* (Boheman) drawn from a specimen from Sierra Leone in the British Museum. A comparison of this figure with the figure cited in the synonymy of the preceding species will show the distinct differences.

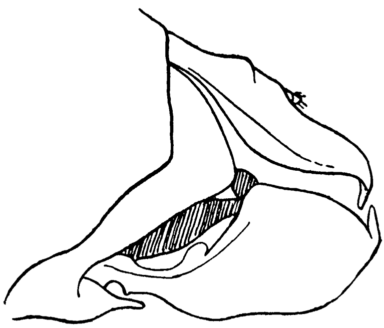


FIG. 4. *Zoraida sinuosa* (Boheman); male genitalia, lateral view.

Zoraida cumulata (Walker).

Zoraida insulicola Kirkaldy, MUIR, Philip. Journ. Sci. § D 12 (1917) 81.

I have examined the type of this species in the British Museum; it is the same as Kirkaldy's species.

Genus LEUROMETOPON nomen novum

Mindana MUIR, Philip. Journ. Sci. § D 12 (1917) 94, preoccupied in Coleoptera, Allard, Bull. ou C. R. Soc. Ent. Belg. 33 (1889) CXII.

I have to thank Doctor Bergroth for pointing out that the name *Mindana,* proposed by me in 1917, is preoccupied in Coleoptera. As a substitute for *Mindana* Muir I offer *Leurometopon.*

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Zoraida kalshoveni* sp. nov.; male genitalia, lateral view.
2. *Zoraida kalshoveni*, sp. nov.; female genitalia, dorsal view.
3. *Zoraida bakeri* sp. nov.; female pregenital plate, lateral view.
4. *Zoraida sinuosa* (Boheman); male genitalia, lateral view.

PHILIPPINE RICE

By A. H. WELLS, F. AGCAOILI, and R. T. FELICIANO

Of the Bureau of Science, Manila

Although rice has constituted the chief staple food of the inhabitants of the Philippine Islands for centuries, very little attention and study have been devoted to it, so that the 36,500,000 cavans of palay produced during 1920 might well be regarded as the result of the bounteousness of the soil rather than the product of the efforts of the farmers. However, the peculiar attitude of scientific men and farmers and their apathy toward its study are not confined to the Philippines, but are found in other oriental rice-producing countries as well. This, in part, is responsible for the prevalence of existing primitive methods of rice culture in the Islands; no great use is as yet made of modern implements, fertilizers, and seed selection. Very little attention has been paid to the study of the chemical composition of the kernels, the leaves, the stems, and the roots at various stages of maturity to determine the food value at such different stages, both to men and to domestic animals, and the relations of the variation of these chemical constituents to irrigation, fertilizers, climatic conditions, etc.

The present paper is simply a compilation of the analyses of the kernels of different varieties of rice received in the Bureau of Science from time to time, and is offered in the hope that it may serve to indicate slightly the more important bearings and relations of chemical research to scientific farming.

Of the many varieties of Philippine rice submitted by the Bureau of Agriculture for phosphorus determination, about twenty-three have been also subjected to a general analysis of percentage of moisture, of ether extract, of protein, of crude fiber, and of carbohydrates and starch. For several years these samples have been kept under close observation by the Bureau of Agriculture for variety tests, and in cultivating them efforts have been directed toward making conditions of growth as nearly uniform as possible.[1]

[1] Camus, José S., Rice in the Philippines, Bull. P. I. Bur. Agr. 37 (1921).

TABLE 1.—*Characters of twenty-three awnless varieties of Philippine rice.*

Variety.	Permanent No.	Origin.	Habitat.	Age at maturity.	Yield per hectare.		Degree of popular acceptance.	Physical characteristics of the grain. Shape.	
								Outline.	Thickness.
				Days.	*Kilos.*	*Cavans.*			
1. Roxas No. I	1004	Tarlac	Lowland	142	2,715	63.14	High	Oblanceolate	Medium
2. Cruz	1003	do	do	141	2,857	66.44	Medium	Elliptic	Fairly plump
3. Apostol IV	1001	Laguna	do	144	2,383	55.41	High	Linear oblong	Somewhat thick
4. Conner	1002	Tarlac	do	142	2,644	61.48	Medium	Elliptic	Medium
5. Macan I	527	Zambales	do	180	2,708	63.00	High	do	do
6. Inasimang	447	Tarlac	do	170	2,854	66.25	Medium	do	do
7. Piniling Daniel	692	do	do	177	2,790	64.48	do	do	do
8. Inantipolo II	956	Cavite	Upland	138	2,378	55.25	High	do	do
9. Dinagat "A" I semi-upland.	362	Laguna	Dual purpose	123	1,904	44.30	Medium	Ovate	Medium
10. Kinandang putc upland	952	Batangas	Upland	106	1,883	43.81	do	Elliptic	do
11. Bad-as	27	Occidental Negros	Lowland	183	2,679	62.25	Medium	Elliptic oblanceclate.	Medium
12. Inachupal	429	Tarlac	do	169	2,624	61.00	do	Elliptic	Thick
13. Jinaloan	469	Occidental Negros	do	183	2,416	56.18	do	Oblong	Plump
14. Jinipon	470		do	170	2,521	58.58	do	Shrimp-shaped	Thin
15. Kinarabao I	486		do	158	2,457	57.10	do	Oblong	Medium
16. Manabaco	578	Antique	do	189	2,536	58.86	do	do	do
17. Manabunac	579	do	do	181	2,536	58.87	High	Elliptic	do
18. Manticanon	598	Tarlac	do	182	2,972	69.12	Medium	do	Thick
19. Molan-ay	629	Antique	do	141	2,399	55.78	do	do	Medium
20. Quinanay	739	Leyte	do	147	1,968	45.76	do	Oblong	do
21. Quinatia I	756	do	do	185	2,866	66.65	do	Elliptic oblong	do
22. Tarbayanon II	860	Misamis	do	144	2,474	57.50	do	do	Thin
23. Virgen	905	Occidental Negros	do	184	2,446	56.83	do	Oblong	Medium

Variety.	Physical characteristics of the grain.								Glutinous (+) or nonglutinous (—).
	Dimensions.		Hispid or glabrous.	Color of—		Thickness of hull.	Color of cuticle.	Flavor.	
	Length.	Width.		Hull.	Tip.				
	mm.	*mm.*							
1. Roxas No. I	8.51	3.16	Hispid	Brown with light stripes.	Straw	Thick	White	Plain	+
2. Cruz	7.81	3.34	do	Straw with purplish shade.	Purplish	Medium	do	Medium	+
3. Apostol IV	8.70	2.98	do	Straw	Straw	do	do	do	+
4. Conner	8.26	3.04	do	do	do	do	do	do	+
5. Macan I	8.05	3.02	do	do	do	do	do	Good	+
6. Inasimang	7.64	3.14	do	do	do	do	do	Medium	+
7. Piniling Daniel	7.83	2.96	do	do	do	do	do	do	+
8. Inantipolo II	7.05	3.05	Glabrous	do	Purplish	do	do	Very good	+
9. Dinagat "A" I semiupland.	7.63	3.01	Hispid	Light straw	Straw	do	do	Medium	+
10. Kinandang pute upland	7.41	3.02	Somewhat hispid	Straw	Light straw	do	do	do	+
11. Bad-as	8.05	3.30	Hispid	Light brown	Light brown	Thick	do	do	—
12. Inachupal	7.70	2.97	do	Straw	Light straw	Medium	do	do	—
13. Jinaloan	8.90	3.75	do	Brown straw	Straw	Thick	Dull white	do	—
14. Jinipon	7.95	2.47	do	do	do	Thin	White	do	—
15. Kinarabao I	9.35	3.75		Straw	do	Thick		do	(?)
16. Manabaco	8.72	2.94	Hispid	Brown straw	Brown	do	Creamy white		+
17. Manabunac	7.24	3.29	do	Straw	Straw	do	White	Good	—
18. Manticanon	7.37	3.17	do	do	do	Thin	do	Medium	—
19. Molan-ay	8.37	3.42	do	Light brownish straw	Purple	do	do	do	—
20. Quinanay	8.95	2.83	do	Straw	Straw	do	do	do	—
21. Quinatia I	7.54	3.13	do	do	do	Medium	do	do	—
22. Tarbayanon II	8.03	2.87	do	Brownish straw	do	Thick	do	do	—
23. Virgen	7.50	2.40	do	Light straw	do	Thin	Amber	do	—

The Philippine Islands, in common with other oriental rice-producing countries, presents a great wealth of varieties which have been classified into groups according to habitat or method of cultivation; namely, upland or lowland rice, awn or awnless, glutinous or nonglutinous. This method of grouping is not strictly scientific; very often there is no definite or distinctive boundary line between several varieties. The designation of a variety as glutinous or nonglutinous, for instance, is not made by a certain definite and arbitrary standard of gluten, above which the sample falls into the glutinous group, and below into the nonglutinous; but, rather, long usage and custom predetermine the class. In some cases the coexistence of certain physical characteristics of the grain places the sample in a certain group. Such physical characteristics include the shape (outline and thickness) of the grain, the length and width of the grain, the color of the hull and tips, the thickness of the hull, the color of the cuticle, the flavor, etc. In Table 1 these different characteristics for the twenty-three varieties under study, together with the origin, habitat, age of maturity, yield per hectare, and degree of popular acceptance are shown.

It is interesting to note from this table that there is a close relationship between the length of maturity and the yield per hectare. The observation is also interesting in that it suggests a method of increasing the yield without expenditure of any special efforts. In general, the late-maturing varieties produce more per hectare than the early-maturing varieties. This fact would seem to be in line with the observations of Chambliss and Adams,[2] who showed that, by allowing the plant a longer time to mature, there resulted "an increase in yield and improvement in quality." Thus, using the same variety for observation these authors found that Wateribune variety gave a yield of 5,350 pounds per acre when allowed to mature in one hundred seventy-four days, and 7,020 pounds in two hundred two days; for Omachi variety, the yield obtained was 5,250 pounds in one hundred seventy-eight days, and 6,730 pounds in two hundred three days. A notable exception, however, is the Carolina Gold, which gave a yield of 4,300 pounds in one hundred eighty-seven days, and only 3,100 pounds in two hundred twelve days; this variety was not acclimatized in California but was grown there only experimentally.

[2] Chambliss, Charles E., and Adams, E. L., Farmers' Bull. U. S. Dept. Agr. 688 (1915).

Such observation, seemingly verified by our table, is suggestive of a method of increasing the yield; that is, it indicates plainly that greater returns could be obtained by simply allowing the crop a longer time in which to mature.

Chemical analysis.—The usual general methods of chemical analysis were followed in this work. All analyses were performed in duplicate to check results; those that did not agree within permissible errors were repeated.

Sampling.—Representative samples were taken from different parts and, levels of a 1-kilogram sack of rice, from which the hulls were removed by grinding the kernels in a mortar, utmost care being taken that no polishing was done to the rice grains. Then 100 unbroken kernels were sorted out at random and weighed, the weight representing the weight of 100 kernels of a variety.

METHODS OF ANALYSIS

Moisture.—Moisture was determined by drying a known weight of a sample (2 to 5 grams) in an electric oven at 100° C. until a constant weight was obtained. The loss in weight represents the moisture present.

Ether extract.—Fats were determined by extracting a weighed sample with ether in a Soxhlet apparatus for forty-eight hours; the ether extract was then freed from ether and moisture, and weighed. This result was checked by drying the ether residue and finding the loss in weight.

Protein.—The indirect method of obtaining protein was used. Nitrogen was first determined by Gunning's modification of Kjeldahl's nitrogen determination and then this value was converted by a factor (6.25) into protein.

Crude fiber.—Crude fiber was determined by boiling the residue from the ether extract with 1.25 per cent sulphuric acid for a half hour, then washing it free from acid; the product was again boiled with 1.25 per cent sodium hydroxide for another half hour. The undissolved residue was washed free from alkali, filtered, dried, and weighed. This weight minus the weight of the ash represents the crude fiber.

Ash.—The ash was determined by incinerating carefully the dried sample from the moisture determination. The weight of the whitish or grayish residue, free from carbon, left after careful incineration represents the ash content.

Carbohydrates.—Carbohydrates, starch, etc., other than crude fiber, were obtained by difference.

TABLE 2.—*Results of the analysis of twenty-three varieties of rice cultivated in the Philippines.*

Variety.	Permanent No.	Weight of 100 kernels.	Moisture.	Ether extract.	Protein (N × 6.25)	Crude fiber.	Ash.	Carbohydrates starch, etc., other than fiber (by difference).	Phosphorus pentoxide.	Food value per 100-gram sample.
		Grams.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
1. Roxas No. I	1004	2.1790	12.93	1.70	7.88	0.93	1.33	75.23	0.714	356.53
2. Cruz	1003	2.2225	12.10	0.93	8.09	1.21	1.26	76.41	0.695	354.22
3. Apostol IV	1001	1.784	14.53	1.56	8.01	0.88	1.29	73.73	0.766	349.01
4. Conner	1002	2.0285	11.90	2.03	8.14	0.99	1.18	75.76	0.767	362.10
5. Macan I	527	1.6725	12.53	0.83	8.23	1.02	1.49	75.90	0.773	352.25
6. Inasimang	447	1.7200	12.03	0.51	8.10	1.00	1.13	77.23	0.628	354.24
7. Piniling Daniel	692	1.8825	12.02	1.41	7.96	0.95	1.30	76.36	0.729	358.05
8. Inantipolo II	956	1.8850	12.88	1.01	7.83	1.03	0.79	76.46	0.501	354.18
9. Dinagat "A" I semiupland	362	1.9080	12.50	2.29	7.58	1.13	1.15	75.35	0.700	361.22
10. Kinanda pute upland	952	2.2990	13.43	1.87	8.31	1.01	1.19	74.19	0.690	355.24
11. Bad-as	27	2.0370	14.9	3.43	7.00	1.09	1.78	72.89	1.030	359.39
12. Inachupal	429	1.7620	14.15	3.70	8.31	1.00	2.21	71.63	0.980	362.16
13. Jinaloan	469	2.2345	14.6	2.46	8.54	1.18	1.20	72.02	0.706	357.48
14. Jinipon	470	1.8067	14.11	2.71	8.31	1.01	1.19	72.67	0.693	355.34
15. Kinarabao I	486	2.2823	9.96	2.53	7.33	1.35	1.69	77.14	0.837	370.08
16. Manabaco	578	1.7620	13.15	4.14	8.66	1.08	2.03	70.94	0.892	364.22
17. Manabunac	579	1.7968	10.65	3.73	7.66	1.31	1.55	75.10	0.79	374.40
18. Manticanon	598	2.0558	11.05	2.28	7.48	1.32	1.31	77.88	0.81	370.98
19. Malon-ay	629	2.2652	9.62	1.24	7.88	1.76	1.26	80.00	0.71	371.12
20. Quinanay	739	2.0356	11.28	1.36	8.49	1.20	2.88	74.79	0.952	304.29
21. Quinatia I	756	2.0324	10.72	1.07	7.57	2.26	2.14	78.50	0.77	362.52
22. Tarbayanon II	860	1.9056	10.73	1.68	8.09	1.19	0.77	76.56	0.552	366.92
23. Virgen	905	1.8663	10.48	2.23	7.00	1.25	1.23	77.81	0.652	368.63
Average		1.9706	12.26	2.03	7.93	1.18	1.45	74.98	0.752	360.63

Table 2 shows the composition of the different varieties examined. Attention is called to the great variation in the percentages of composition of moisture, fats, protein, and carbohydrates; and, as the different varieties were cultivated under identical conditions, these differences in chemical composition must be attributed to variety characteristics.

Energy content.—The food value of the twenty-three varieties expressed in calories gives an average of 360 calories per 100 grams (see Table 2). Assuming the average expenditure of a normal healthy working man to be 3,000[3] calories, daily, he would require about 832 grams a day of Philippine rice to supply this energy.

Table 3 shows the average percentage composition of the samples analyzed compared with rice grown in the United States.[4]

TABLE 3.—*Comparison of chemical composition of Philippine rice with rice grown in the United States, both unpolished.*

	Philippine Islands.	United States.
One hundred kernels ......grams..	1.97	2.46
Moisture ......per cent..	12.26	11.88
Protein ......do.....	7.93	8.02
Ether extract ......do.....	2.03	1.96
Carbohydrates:		
Crude fiber ......do.....	1.18	0.93
Other than crude fiber ......do.....	75.89	76.05
Ash ......do.....	1.45	1.15
Phosphorus pentoxide ......do.....	0.752	0.4(?)

From Table 3 it is seen that Philippine rice compared with rice grown in the United States is poorer in protein matter and carbohydrates (starch, etc., other than crude fiber), but is richer in fats and phosphorus; it also contains more moisture, crude fiber, and inorganic salts. Improvement in the quality of Philippine rice should be made along the line of these deficiencies; that is, toward increase in the protein and carbohydrates. This would seem possible, as indicated by recent investigations by Kelley and Thompson,[5] who have shown that the chemical composition of rice kernels, as well as other parts, is greatly in-

[3] Sherman, Henry C., Chemistry of Food and Nutrition. The Macmillan Company, New York (1911) 155.

[4] Bull. U. S. Dept. Agr., Bur. Chem. 13[9]: 1212.

[5] Kelley, W. P., and Thompson, Alice R., A Study of the Composition of the Rice Plant, Bull. U. S. Dept. Agr. Hawaii Agr. Exp. Sta. 21 (1910).

fluenced by several factors; namely, climatic conditions during plant growth, seasonal variation, type of soil, and nature of fertilizers used. All other factors being identical the effect of seasonal variation alone on the composition of the grain is shown in Table 4.

TABLE 4.—*The effect of seasonal variations in the water-free composition of grain at maturity.*

	Spring crop.	Fall crop.
	Per cent.	*Per cent.*
Nitrogen	1.24	1.22
Potash	0.41	0.39
Phosphoric acid	0.92	0.83
Carbohydrates	83.80	80.29

As the seasonal variation in this country is very slight throughout the year, its effect can be practically eliminated from consideration. This would seem to suggest that the problem of improving the quality of rice resolves itself into a proper control of fertilizers, methods of cultivation, and irrigation. The effects of different fertilizers on the rice composition can be seen from Table 5.

TABLE 5.—*Water-free composition at maturity of grain.*

Composition.	Check Plate I.	Mineral Plate II.	Nitrogen Plate III.	Complete fertilizer IV.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Nitrogen	1.36	1.36	1.31	1.24
Potash	0.39	0.44	0.42	0.41
Phosphoric acid	0.98	0.92	0.89	0.92
Lime	0.02			0.02
Magnesia	0.27			0.25
Carbohydrates	79.66	80.97	83.52	83.80

Thus, by the use of a complete fertilizer, the carbohydrate content has been improved from 79.66 per cent to 83.80 per cent, an increase of 4.14 per cent, this at the expense of protein matter, as the table shows. However, in the mineral plate, the nitrogen content remains the same, while the carbohydrates have been increased. It is possible, by the use of proper proportions of the ingredients in the fertilizer, to increase both the carbohydrate and the protein contents.

SUMMARY

1. The scientific control of fertilizers, cultural methods, irrigation, etc., are very important factors in improving the yield and the quality of rice; the simple expedient of allowing the rice a longer time in which to mature will undoubtedly be beneficial.

2. Philippine rice compares very favorably with rice grown in the United States.

3. Improvement in quality should be directed to increasing the percentage of protein and carbohydrate contents.

THE FOOD VALUE OF PHILIPPINE BANANAS

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Of the Bureau of Science, Manila

INTRODUCTION

One of the well-known and most-important fruits throughout the Philippine Archipelago is the banana. It is highly esteemed by rich and poor alike, since it is not only economical but also wholesome, delicious, and very appetizing. Furthermore, it is the most plentiful of the Philippine fruits, being found at all times in the Philippine markets. Therefore, this fruit is very popular. Although it has long been an important article of our diet, no practical systematic work has been carried out in studying its chemical composition, and consequently we do not know definitely to what extent and in what way Philippine bananas aid the human system.

There are some interesting features of the bananas that are worthy of note. The fruit can be preserved in many ways without deterioration, and it can be shipped easily from one place to another. The suckers are well suited for transport over long distances without injury. The plant grows in a great variety of soils and under widely varying conditions. Unfortunately, Philippine bananas do not receive any kind of cultivation, being planted usually about dwelling houses for immediate consumption. If given the right scientific treatment and culture the commercial and food values of Philippine bananas can hardly be overestimated.

There are many varieties of Philippine bananas, each of which has distinct characteristic taste and flavor. Some are somewhat acid, and others are sweet. Of some varieties the fruits are eaten raw, while those of others, like the saba, must be cooked first to make them more palatable. In the best varieties the pulp is soft and has a pleasing, delicate flavor. The bananas treated of in this paper are the common ones that Filipinos use constantly as food.[1] They are greatly appreciated by both Filipinos and foreigners.

[1] For botanical descriptions and illustrations of Philippine bananas see Philip. Journ. Sci. § C 10 (1915) 384, and Philip. Agr. Rev. 12 No. 3 (1919).

TABLE 1.—*Data of analyses of the fruits of twelve varieties of Philippine bananas.*

Scientific name.	Local name.	Average weight of one fruit.	Skin.	Edible portion.	Water.	Ether extract.	Protein (N × 6.25).	Sugars.		Starch and other carbohydrates (by difference).	Crude fiber.	Ash.	Acidity as sulphuric acid.	Calorific value per 100 grams of food.
								Sucrose.	Reducing.					
		g.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Musa sapientum var. *ternatensis* (Blanco) Teodoro.	Gloria, ternate	95.8	38.9	61.1	66.56	0.69	1.07	2.03	25.0	3.41	0.31	0.93	0.34	136.9
Musa sapientum var. *compressa* (Blanco) Teodoro.	Saba	50.7	39.0	61.0	69.16	0.71	0.93	4.86	17.20	5.85	0.28	1.01	0.64	126.0
Musa sapientum var. *cinerea* (Blanco) Teodoro.	Latundan, letondal.	62.7	25.8	74.2	70.19	0.63	1.59	0.94	22.72	2.43	0.53	0.97	0.44	121.5
Musa sapientum var. *suaveolens* (Blanco) Teodoro.	Buñgulan	135.0	31.8	68.2	71.17	0.74	1.33	7.89	16.89	0.72	0.44	0.82	0.28	118.7
Musa sapientum var. *lacatan* (Blanco) Teodoro.	Lacatan	72.4	23.6	76.4	70.96	0.67	1.61	16.33	7.46	1.55	0.38	1.04	0.31	118.3
Musa sapientum var. *grandis* Teodoro.	Sabang Iloco	261.0	40.8	59.2	70.59	0.28	1.49	0.23	19.23	6.73	0.48	0.97	0.40	118.1
Musa sapientum var. *inarnibal* Teodoro.	Inarnibal	34.9	25.7	74.3	72.87	0.66	1.68	15.00	6.41	1.93	0.52	0.93	0.33	110.8
Musa sapientum var. *violacea* (Blanco) Teodoro.	Morado	71.9	38.0	62.0	73.35	0.57	1.47	17.73	4.27	1.15	0.58	0.88	0.29	108.6
Musa sapientum var. *principe* Quisumbing.	Principe	99.0	42.7	57.3	73.69	0.41	1.42	16.95	4.09	2.06	0.61	0.77	0.30	106.9
Musa paradisiaca var. *magna* (Blanco) Teodoro.	Tundoc, tondoc	446.5	16.0	84.0	68.66	0.80	1.48	1.33	22.73	3.49	0.35	1.16	0.53	127.9
Musa paradisiaca var. *maxima* (Blanco) Teodoro.	Matavia, batavia	181.2	45.3	54.7	69.97	0.59	1.03	3.16	18.52	5.49	0.32	0.92	0.54	122.4
Musa errans var. *botoan* Teodoro	Butuhan, butuan	104.4	41.3	58.7	83.08	0.40	1.01	0.15	10.75	3.03	0.50	1.08	0.22	67.0

METHODS OF ANALYSIS [2]

In analyzing these fruits eight determinations were made; namely, water, ether extract, protein, sucrose, reducing sugars, crude fiber, ash, and total acidity. The average weight of the fruit and the percentages of the edible and waste portions were taken. Ripe fruits in sound condition were used in the analyses. The edible and waste portions were carefully separated and the former ground in a mortar until uniform representative samples could be obtained.

Sulphuric acid was adopted as the term for the expression of acidity because of its convenience in allowing comparison. Besides, I found that the acidity of the banana is due to the mixture of butyric and citric acids. Furthermore, a part of the acidity may be due to the presence of acid salts, so that an attempt to express the total acidity in terms of a single organic acid characteristic of the fruit would obviously meet with difficulties. Sulphuric acid has already been adopted by a number of laboratories for similar work, and it is accepted here as offering the most satisfactory basis for the expression of acidity in this fruit.

FUEL VALUE

In order to express the capacity of the banana for yielding heat or energy to the body the term fuel value is here used. By the fuel value of a food is meant the amount of heat, expressed in calories, equivalent to the energy which we assume the body could obtain from a given weight of that food material if all of its nutrients were thoroughly digested, a calorie being the amount of heat required to raise a kilogram of water 1° C. This definition applies to what is known as the large calorie, which is one thousand times as large as the small calorie. The fuel value then of this fruit is calculated by means of the factors of Rubner, in accordance with which the amount of energy in 1 gram of each of the three principal classes of nutrients are: For carbohydrates, 4.1; for protein, 4.1; and for fats, 9.3.

Table 1 shows the results of analyses of twelve varieties of Philippine bananas.

CONCLUSION

The components that make up the edible portion of the Philippine banana include water, fat, protein, carbohydrates, organic acids, and mineral matter. Of these water is hardly to

[2] The methods of analysis used are in accordance with Bull. U. S. Bur. Chem. 107 rev. ed. (1908).

be considered as a nutrient, though it plays an important part in food as a diluent and solvent. The fat, protein, and carbohydrates contribute in varying degree to the supply of fuel for the production of heat and energy. Besides this universal function, the fat and the carbohydrates serve especially to furnish fatty tissue in the body, while the protein is the chief source of muscular tissue. The organic acids are minor, though important, constituents of food. Because of their conversion into carbonates within the body, they are useful in furnishing the proper degree of alkalinity to the blood and to the various other fluids, besides being of particular value as appetizers. The mineral or inorganic salts are necessary to supply material for the teeth and bones, besides having an important place in the formation of hæmoglobin in the blood and in the cellular structure of the entire body.

Philippine bananas, as shown by the analyses, are essentially carbohydrate foods, the percentages of protein and fat being correspondingly low. Their nutritive value lies chiefly in the sugars they contain, although the acids and salts exercise an important function in the digestive processes. The sugars are present, both as reducing and as sucrose, which in the gloria, or ternate, as it is sometimes called, reach a maximum total amount of 27.03 per cent. In reality this variety has the highest fuel value.

Although the banana is rich in carbohydrates, its low content of protein indicates that it is not a well-balanced ration, but should be eaten with beans, peas, or other vegetables rich in protein, or with lean meat, in order to secure a proper quantity of protein in the diet.

It is worthy of mention that from the green fruits of the saba and the sabang Iloco I have successfully prepared good banana flour and banana coffee which, although not of the same quality as our commercial flour and coffee, make good substitutes for them and have excellent food values.

Therefore, the Philippine banana is not only important commercially, but also valuable as part of our daily food.

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THE PHILIPPINE JOURNAL OF SCIENCE

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NEW OR NOTEWORTHY PHILIPPINE PLANTS, XVII

By ELMER D. MERRILL

Director and Botanist, Bureau of Science, Manila

The last paper of this series was published in 1920.[1] In the present paper one hundred six new species are described from various parts of the Philippines, while a redescription of *Ficus argentea* Blanco is included. This species, previously known only from Blanco's imperfect description, on receipt of material agreeing with his description in all essentials proves to be a valid one. *Polychroa* Loureiro is accepted as the proper generic name for the group long known as *Pellionia* Gaudichaud, while the few Philippine forms formerly placed in *Polytrema* are now transferred to *Hallieracantha.* Three genera, *Pyrenaria, Pleiocarpidia,* and *Cowiea,* the latter a recently described genus previously known by a single species in British North Borneo, are recorded from the Philippines for the first time. A few notes on nomenclature are included, which involve some changes in specific names.

GRAMINEAE

ICHNANTHUS Beauvois

ICHNANTHUS VICINUS (F. M. Bail.) comb. nov.

Panicum vicinum F. M. Bail. Syn. Queensl. Fl. Suppl. 3 (1890) 82.

Ichnanthus pallens Munro in Benth. Fl. Hongk. (1861) 414; Merr. in Philip. Journ. Sci. 1 (1906) Suppl. 261, 363; Hack. in Govt. Lab. Publ. (Philip.) 35 (1906) 80, non *Panicum pallens* Sw.

Panicum paludicolum Miq. Fl. Ind. Bat. 3 (1857) 454; F.-Vill. Novis. App. (1882) 312, non Nees.

Panicum nitens Merr. in Govt. Lab. Publ. (Philip.) 17 (1904) 8.

[1] Merrill, Elmer D., New or noteworthy Philippine plants, XVI, Philip. Journ. Sci. 17 (1920) 239–323.

Luzon (Kalinga, Bontoc, Bataan, Laguna, Sorsogon), Catanduanes, Mindoro, Biliran, Mindanao. *Merrill 3756, 3221, 5498, 5538, Phil. Pl. 109, Kneucker Gram. Exsic. 740, B. S. 30226, 23608 Ramos, 18502 McGregor, 37475, 38608 Ramos & Edaño.* On forested slopes and ridges up to 1,600 m altitude. India to southern China and Formosa through Malaya to tropical Australia.

The Old World form has long been referred to *Ichnanthus pallens* (Sw.) Munro, the type of which was from tropical America. The Indian, Chinese, Philippine, Malayan, and Australian material consistently differs from the American material in its larger spikelets. A fragment of Bailey's type of *Panicum vicinum* has kindly been supplied to me by Mr. T. C. White of Brisbane, and it is identical with the Asiatic and Malayan form. I had long suspected that our form was specifically distinct from the American one, because as it occurs in the Old World it is a native, not an introduced, grass. This suspicion has been verified by Prof. A. S. Hitchcock, who went over the material with me, first in Washington and more recently in Manila, and who likewise considers the Old World form to be specifically distinct from the American one.

In addition to the Philippine material and the Australian type mentioned above the species is represented in the Bureau of Science herbarium by specimens from the Malayan Peninsula, southern China, Formosa, Sumatra, Java, New Guinea, and Australia.

MORACEAE

FICUS Linnaeus

FICUS ARGENTEA Blanco Fl. Filip. (1837) 681, ed. 2 (1845) 473, ed. 3, 3 (1879) 84.

Ficus polycarpa F.-Vill. Novis. App. (1880) 200, non Roxb.

Ficus sp. Merr. Sp. Blancoanae (1918) 129.

A tree about 8 m high, glabrous except the very densely pubescent peduncles and receptacles, the indumentum silvery white to pale ferruginous. Branches somewhat rugose, reddish-brown, glabrous, the ultimate ones 6 to 8 mm in diameter, the very tips of the branchlets sparingly appressed-pubescent. Leaves somewhat crowded at the tips of the branchlets, oblong to oblong-elliptic, chartaceous to subcoriaceous, smooth, entire, brownish olivaceous, slightly shining, the lower surface rather minutely puncticulate-verruculose, 11 to 15 cm long, 5 to 6.5 cm wide, the apex rather acuminate, the base rounded and somewhat 3-nerved; primary lateral nerves 10 to 12 on each side of the midrib,

slender, distinct as are the rather close reticulations; petioles reddish-brown when dry, 5 to 7 cm long; stipules broadly ovate, shortly acuminate, pubescent, about 6 mm long. Receptacles borne in fascicles along the ultimate branches below the leaves, usually 3 or 4 in a fascicle, the fascicles numerous, the individual receptacles globose to slightly obovoid, 6 to 7 mm in diameter, very densely and softly pubescent with silver white to pale ferruginous hairs, their peduncles densely pubescent, about 5 mm long, the bracts subtending the receptacles broadly ovate, obtuse, glabrous or slightly pubescent, 1.5 to 2 mm long. Male flowers few, only near the ostiole, the stamen 1, about 0.5 mm long. Ovaries of the gall flowers and fertile female flowers ovoid, about 1 mm long, the styles of the former about 0.5 mm in length, those of the latter 1 mm long. Perianth segments membranaceous, oblong-lanceolate, about 1 mm long.

MINDORO, Paluan, *Bur. Sci. 39732 Ramos,* April 9, 1921. In dry forests at low altitudes.

This species is closely allied to *Ficus stipulosa* Miq. which has been reduced by some authors to the widely distributed Indo-Malayan *Ficus infectoria* Roxb. It is readily distinguished by its very densely pale pubescent peduncles and receptacles. Blanco described the receptacles as flowers and the subtending bracts as the calyx. The specimens on which the above description was based agree very closely with Blanco's original description except that the leaves are scarcely undulate, while the receptacles are globose to slightly obovoid rather than "de figura de trompa," that is, pyriform. I have seen no other species of *Ficus* that even remotely agrees with Blanco's imperfect description and am confident that the plant here considered represents the form he so imperfectly described. In my Species Blancoanae (1918) 129, I expressed the opinion that *Ficus argentea* Blanco might have been based on immature specimens of *Ficus ruficaulis* Merr. but the recent receipt of material agreeing essentially with Blanco's description shows that this surmise was wrong.

FICUS XAVIERI sp. nov. § *Urostigma.*

Species F. benjaminae simillimis et affinis differt receptaculis dense et molliter cinereo-pubescentibus.

A strangling fig reaching a height of 10 m or more, branches and receptacles densely and softly cinereous-pubescent. Branches glabrous, terete, grayish, the younger ones more or less rugose, the young branchlets 2 to 2.5 mm in diameter.

Leaves ovate to elliptic, subcoriaceous, 6 to 10 cm long, 3 to 5 cm wide, rather pale when dry, glabrous, shining, the base broadly acute to rounded, the apex rather abruptly subcaudate-acuminate, the acumen up to 1 cm in length, rather slender, obtuse to acute; lateral nerves numerous, spreading, parallel, the secondary ones practically as prominent as the primary ones, anastomosing close to the edge of the leaf and forming a very slender, somewhat arched, marginal nerve, 1 to 2 mm from the edge of the leaf; petioles 8 to 15 mm long, not jointed, pubescent when young, ultimately glabrous, slender, rather deeply channeled on the upper surface; stipules narrowly lanceolate, 1.5 cm long, glabrous or nearly so, slenderly acuminate. Receptacles globose to ovoid, axillary, sessile, densely and softly cinereous-pubescent, solitary or in pairs, 8 to 12 mm in diameter, the subtending bracts usually 2, pubescent, 2 to 3 mm long, 4 to 8 mm wide, the ostiole obscure. Staminate flowers few, scattered, the perianth segments 3, spatulate, brown, 2 mm long; anthers about 0.6 mm long. Fertile female flowers numerous, their perianth segments similar to those of the staminate flowers, the ovary subellipsoid, about 1 mm long, rounded; styles slender, 2 mm long. Gall flowers similar to the fertile female ones except that the styles are wanting or very short. Bracteoles linear, about 2 mm long.

LUZON, Laguna Province, Los Baños, *F. X. Williams s. n.*, and *For. Bur. 28480 Salvosa,* June, 1921, from the same tree. In forests along Molauin River near the College of Agriculture, altitude about 120 meters, growing on *Bischofia javanica* Blume.

This species is dedicated to Mr. Francis Xavier Williams, entomologist of the Hawaiian Sugar Planters' Experiment Station, who also collected botanical material from the same tree. Mr. Williams has devoted a considerable amount of time to a study of the Philippine fig insects with the view to their possible introduction into Hawaii. It is at once distinguished from *Ficus benjamina* Linn., which it closely resembles, by its densely pubescent receptacles.

FICUS KALINGAENSIS sp. nov. § *Covellia.*

Species F. myriocarpae Miq. affinis differt foliis basi truncato-rotundatis, haud cordatis, receptaculis majoribus, longiter pedunculatis.

A tree about 5 m high, the branches reddish-brown, wrinkled, glabrous, the very young branchlets supplied with scattered, spreading, slender, rather stiff hairs up to 6 mm in length.

Leaves alternate, long-petioled, broadly ovate, thickly chartaceous or subcoriaceous, 17 to 22 cm long, 12 to 16 cm wide, the base rather broadly truncate-rounded, apex acuminate, margins rather finely serrate, both surfaces rather harsh, the upper surface olivaceous, supplied with widely scattered, white, stiff, spreading hairs, the lower surface paler, distinctly pubescent on the midrib, nerves, and reticulations, and with scattered, elongated, stiff hairs on the midrib and lateral nerves similar to those on the upper surface; lateral nerves 10 to 12 on each side of the midrib, prominent, nearly straight, the primary reticulations subparallel, distinct; petioles 6 to 10 cm long, supplied with scattered, elongated, stiff hairs similar to those on the branchlets; stipules broad, up to 4 cm long, acuminate, glabrous except on the median portion of the back below, which is supplied with scattered, elongated hairs similar to those on the branchlets. Inflorescences cauline, apparently from near the base of the trunk, elongated, simple, up to at least 30 cm in length, glabrous or nearly so, the rachis about 5 mm in diameter. Receptacles fascicled at the nodes or on the stout, slightly produced, lateral branches, globose to obovoid, about 8 mm in diameter, brown when dry, distinctly lenticellate, minutely furfuraceous, their peduncles up to 12 mm long, the receptacles subtended by 3, ovate, minutely pubescent, acute bracts about 2.5 mm in length. Inside of the receptacles somewhat ciliate. Male flowers not seen. Fertile female flowers sessile or pediceled, their perianth segments oblong-obovate, about 2 mm long, slightly ciliate at the tips; styles about 1 mm long.

LUZON, Kalinga Subprovince, Mount Masingit, near Lubuagan, *Bur. Sci. 37592 Ramos & Edaño*, February 17, 1920. Along streams in the mossy forest, altitude about 1,300 meters.

A species closely allied to *Ficus myriocarpa* Miq. which is known only from Amboina Island. It resembles this species in its habit, its vegetative characters, indumentum, and the arrangement of its receptacles. It differs notably in its truncate-rounded, not cordate, leaf bases and in its larger and longer-peduncled receptacles.

URTICACEAE

ELATOSTEMA Forster

ELATOSTEMA BONTOCENSE sp. nov.

Herba erecta, ramosa, succulenta, saltem ad 40 cm alta, ramis plus minusve adpresse hirsutis; foliis numerosissimis, parvis, valde inaequilateralibus, chartaceis, glabris, olivaceis, circiter

1 cm longis, 5 mm latis, cystolithis paucis vel nullis, apice obtusis vel subacutis, dentibus utrinque 2 vel 3, obtusis; nervis 1 vel 2 utrinque; stipulis anguste oblongis, glabris, 1.4 mm longis; inflorescentiis ♂ axillaribus, solitariis, sessilibus, paucifloris, bracteis liberis, exterioribus ellipticis, obtusis, 2 mm longis, bracteolis oblongis ad oblongo-ellipticis; floribus 3 vel 4, 5-meris, segmentis ellipticis, leviter cucullatis, ciliatis, 2 mm longis.

An erect, apparently succulent, much-branched herb, at least 40 cm high, the stems and branches somewhat appressed-hirsute with short hairs. Leaves very numerous, glabrous, chartaceous, very inequilateral, oblong to oblong-ovate, generally about 10 mm long and 5 mm wide, brownish olivaceous when dry, sometimes with obvious cystoliths along the midrib and nerves on the upper surface, more often without evident cystoliths, the apex obtuse or subacute, the base very inequilateral, acute on the narrower side and broadly rounded on the wider side, the narrower side with usually 2 teeth in the upper part, the broader side with usually 3 teeth, the teeth obtuse; nerves 1 or 2 on each side of the midrib; stipules narrowly oblong, glabrous, 1.4 mm long. Staminate inflorescences axillary, solitary, sessile, obovoid, few-flowered, 2 or 3 flowers only in each fascicle, the bracts free, the outer ones elliptic, obtuse, 2 mm long, the bracteoles oblong-elliptic, thinner than the bracts and about one-half as wide. Perianth segments 5, elliptic, slightly cucullate, rather prominently ciliate, about 2 mm long.

LUZON, Bontoc Subprovince, Mount Polis, *Bur. Sci. 37660 Ramos & Edaño*, February 25, 1920. On tree trunks in the mossy forest, altitude about 1,800 meters, with the local name *n̄galn̄galoi*.

This species belongs in the group with *Elatostema podophyllum* Wedd. and *E. benguetense* C. B. Rob., but is easily distinguishable from these two species by the few, or more often obsolete, cystoliths.

ELATOSTEMA CAPIZENSE sp. nov.

Herba erecta ut videtur succulenta, usque ad 40 cm alta, simplex, caulis deorsum prostratis; foliis membranaceis, plus minusve inaequilateralibus, oblongo-ellipticis ad anguste oblongo-obovatis, glabris, 11 ad 17 cm longis, olivaceis vel brunneis, cystolithis numerosis instructis, basi acutis, apice subabrupte caudato-acuminatis, margine in $\frac{1}{3}$ superiore parte distanter crenato-serratis, deorsum integris; nervis utrinque circiter 8,

reticulis obscuris, laxis; inflorescentiis ♀ solitariis, sessilibus, 10 ad 12 mm diametro, bracteis connatis, lobis numerosis, linearis ad lineari-lanceolatis, circiter 3 mm longis, ciliatis, bracteolis linearis ad spatulatis, 2.5 ad 3 mm longis, perspicue ciliatis; pedicellis circiter 1.5 mm longis; acheniis brunneis, subellipsoideis, subacutis, 0.6 mm longis.

An erect, apparently succulent, unbranched herb, up to 40 cm high, the basal portion of the stem somewhat prostrate, the stems apparently succulent when fresh, without cystoliths. Leaves membranaceous when dry, sessile or subsessile, somewhat inequilateral, oblong-elliptic to narrowly oblong-obovate, 11 to 17 cm long, 4 to 6 cm wide, olivaceous or brownish when dry, the apex slenderly and rather abruptly caudate-acuminate, the base somewhat inequilateral, narrow, acute on the narrower side, acute or slightly obtuse on the broader side, the margins in the lower one-half to two-thirds entire, in the upper part very distantly crenate-serrate, the upper surface with numerous cystoliths, distinctly visible to the naked eye, the lower surface of the same color as the upper, the cystoliths conspicuous; lateral nerves about 8 on each side of the midrib, distinct, anastomosing directly with the marginal nerves, the reticulations lax, obscure; stipules lanceolate, glabrous, membranaceous, acuminate, up to 1 cm long. Pistillate inflorescences axillary, solitary, 10 to 12 mm in diameter, apparently somewhat flattened, the bracts united to form a flattened receptacle 5 to 7 mm in diameter, the lobes of the receptacle numerous, linear to linear-lanceolate, acuminate, about 3 mm long, ciliate; bracteoles very numerous, linear to spatulate, 2.5 to 3 mm long, prominently ciliate; pedicels slender, about 1.5 mm long. Achenes brown, subellipsoid, about 0.6 mm long, subacute.

PANAY, Capiz Province, Mount Macosolon, *Bur. Sci. 30748 Ramos & Edaño,* April 19, 1918. On bowlders along small streams in damp forests at low altitudes.

This species was originally identified as *Elatostema integrifolium* Wedd., which it somewhat resembles in vegetative characters, but to which it is not closely allied. Striking differential characters of the present species are its membranaceous, caudate-acuminate leaves which are entire below and distinctly crenate-serrate above; its bracts being united to form a common receptacle, the tips of the bracts (lobes) being numerous and linear to lanceolate; and in being entirely glabrous throughout except for the inflorescences.

ELATOSTEMA EDAÑOII sp. nov.

Herba erecta, ramosa, glabra, succulenta, saltem 40 cm alta; foliis numerosis, lanceolatis, chartaceis, in siccitate atro-viridis, 9 ad 11 cm longis, leviter inaequilateralibus, apice acuminatis, basi acutis, margine in $\frac{3}{4}$ inferiore parte integris, sursum dentibus paucis distantibus instructis, cystolithis conspicuis; nervis utrinque circiter 7, tenuibus, supra subobsoletis, reticulis subtus obsoletis; stipulis lanceolatis, glabris, 5 mm longis; inflorescentiis ♂ solitariis, sessilibus, depresso-globosis, circiter 1 cm diametro, bracteis exterioribus liberis, margine ciliatis, reniformi-ovatis, 6 mm longis, 9 mm latis, carinatis, apiculatis, bracteolis oblongis ad obovatis, 4 mm longis, 2 ad 3 mm latis, truncatis, apice ciliatis, lineolatis; floribus 4-meris, pedicellatis, lobis ellipticis, 2.5 ad 3 mm longis, 2 acutis, 2 leviter cucullatis et corniculatis.

An erect, glabrous, branched, succulent herb, at least 40 cm high, the stems and branches apparently succulent, glabrous, without cystoliths. Leaves numerous, lanceolate, chartaceous when dry, dark green in color, 9 to 11 cm long, 1.7 to 2.5 cm wide, slightly inequilateral, the apex acuminate, the base acute, the margins in the lower three-fourths entire, the upper portion with few, very distant, serrate teeth, the upper surface supplied with numerous, irregularly disposed cystoliths which are distinctly visible to the naked eye, the lower surface somewhat paler, without cystoliths, smooth, the midrib conspicuous, the lateral nerves about 7 on each side of the midrib, slender, obsolete on the upper surface, not prominent on the lower surface, arched-anastomosing, the reticulations obsolete; petioles 1 to 2 mm long; stipules lanceolate, acuminate, somewhat falcate, glabrous, about 5 mm long. Staminate inflorescences axillary, solitary, sessile, depressed-globose, up to 1 cm in diameter, the outer two bracts reniform-ovate, about 6 mm long, 9 mm wide, subcoriaceous, keeled, slightly apiculate, the margins minutely ciliate; bracteoles very numerous, oblong to obovate, about 4 mm long, 2 to 3 mm wide, truncate, slightly ciliate at the apex, marked with numerous small, elongated, reddish-brown lines, all more or less concave. Flowers 4-merous, white, the pedicels 2.5 mm long, perianth lobes membranaceous, elliptic, 2.5 to 3 mm long, two acute and two somewhat cucullate and shortly spurred, the spur stout, 0.8 mm long, slightly ciliate.

LUZON, Kalinga Subprovince, Mount Masingit near Lubuagan, *Bur. Sci. 37603 Ramos & Edaño*, February 17, 1920. On tree trunks in forests along streams, altitude about 1,300 meters.

A very strongly marked species, well characterized by its conspicuous cystoliths and its nearly entire, lanceolate, very slightly inequilateral, obscurely nerved leaves.

ELATOSTEMA EUPHLEBIUM sp. nov.

Herba suffruticosa, erecta, ramosa, caulis teretibus, 4 ad 5 mm diametro, ramis adpresse cinereo-hirsutis; foliis lanceolatis, subcoriaceis, rigidis, inaequilateralibus, 4 ad 8 cm longis, olivaceis, caudato-acuminatis, margine acute et grosse serratis, dentibus acuminatis, supra cystolithis numerosis instructis, junioribus plus minusve ciliatis, nervis utrinque 6 vel 7, impressis, subtus valde perspicuis et adpresse hirsutis; stipulis 4 mm longis; inflorescentiis ♂ solitariis, sessilibus vel subsessilibus, usque ad 6 mm diametro, multifloris, bracteis exterioribus orbiculari-ovatis, rotundatis, leviter ciliatis, liberis, bracteolis angustis, ciliatis, floribus 4-meris, lobis oblongo-ovatis ad spatulatis, 2 mm longis, haud corniculatis, 2 leviter cucullatis, supra leviter ciliatis.

An erect or ascending, much-branched, suffrutescent plant, the stems distinctly woody, terete, 4 to 5 mm in diameter, the branches usually 20 cm long or less, appressed-hirsute with cinereous hairs. Leaves inequilateral, lanceolate, rigid, subcoriaceous, 4 to 8 cm long, 10 to 18 mm wide, olivaceous, the apex caudate-acuminate, base inequilateral, acute on the narrower side, obtuse on the broader side, the margins sharply and rather coarsely serrate, the teeth somewhat acuminate, the upper surface with numerous cystoliths and when young supplied with numerous, stiff, white hairs, these hairs more or less deciduous on the older leaves, some, however, usually persisting, their bases often thickened, the lower surface paler than the upper, the midribs and nerves appressed-hirsute, the cystoliths conspicuous, the midrib and lateral nerves impressed on the upper surface, very prominent on the lower surface, the lateral nerves 6 or 7 on each side of the midrib, arched-anastomosing; stipules lanceolate, acuminate, about 4 mm long. Staminate inflorescences axillary, solitary or in pairs, sessile or very shortly peduncled, up to 6 mm in diameter, many-flowered, outer bracts orbicular-ovate, about 3 mm long, rounded, somewhat ciliate, free, the bracteoles narrow, ciliate. Flowers 4-merous, the lobes oblong-ovate to spatulate, 2 mm long, slightly ciliate above, two of them slightly cucullate, none spurred.

LUZON, Bontoc Subprovince, Mount Pukis, *Bur. Sci. 37765 Ramos & Edaño,* March 10, 1920. On forested slopes, altitude about 1,800 meters.

This species has much the habit of *Elatostema kalingaense* Merr. and, like that species, resembles in vegetative characters *E. contiguum* C. B. Rob. It differs from Robinson's species in the same characters as does *E. kalingaense*, and from the latter species in its much thicker, very conspicuously nerved leaves, the midribs and lateral nerves being strongly impressed on the upper surface.

ELATOSTEMA KALINGAENSE sp. nov.

Herba ramosa, glabra, caulis deorsum decumbens, ramis adpresse strigoso-hirsutis; foliis membranaceis, lanceolatis, leviter falcatis, 4 ad 6 cm longis, tenuiter caudato-acuminatis, margine grosse serratis; inflorescentiis ♂ solitariis, sessilibus, 5 mm diametro, perspicue ciliatis, bracteis liberis, exterioribus late ovatis, acuminatis, 4 mm longis, bracteolis oblongis ad spatulatis, ciliatis; floribus 4-meris, sessilibus, segmentis perspicue ciliatis, haud corniculatis.

An ascending, branched herb, the lower parts of the stems creeping or prostrate and rooting where in contact with the substratum, greenish-olivaceous when dry, with numerous cystoliths, glabrous or nearly so, the younger branches appressed-strigose-hirsute, rather slender. Leaves membranaceous, dark green when dry, lanceolate, somewhat falcate, 4 to 6 cm long, 9 to 12 mm wide, the apex slenderly caudate-acuminate, the base inequilateral, acute on the narrower side, rounded to obtuse on the broader and longer side, the margins coarsely serrate, the teeth somewhat acuminate, the upper surface with numerous irregularly disposed cystoliths and with few, stiff, elongated, somewhat curved hairs from swollen bases, the lower surface slightly paler than the upper, the cystoliths distinct, the midrib and nerves more or less appressed-strigose-hirsute; stipules linear, lanceolate, about 2 mm long. Staminate inflorescences axillary, solitary, about 5 mm in diameter, many-flowered, conspicuously ciliate with grayish hairs, the bracts free, the outer ones broadly ovate, acuminate, prominently ciliate, about 4 mm long; bracteoles oblong, spatulate, ciliate and nearly as long as the bracts. Flowers numerous, sessile, 4-merous, the perianth segments oblong to spatulate, obtuse, 2 mm long, two somewhat cucullate, none spurred, all conspicuously ciliate above.

LUZON, Kalinga Subprovince, Mount Masingit, near Lubuagan, *Bur. Sci. 37493 Ramos & Edaño*, February 16, 1920. On bowlders or ledges along streams, altitude about 1,200 meters.

This species in vegetative characters closely approximates *Elatostema contiguum* C. B. Rob., but differs radically in its

habit, being freely branched, and further differs in its floral characters. It is very easily distinguished from *Elatostema lignosum* Merr. by its entirely different habit, the stems creeping and rooting below not being strictly erect and woody. The floral characters of the two species are radically different.

ELATOSTEMA LIGNOSUM sp. nov.

Erecta, ramosa, fruticosa, usque ad 80 cm alta, caulis teretibus, lignosis, 4 ad 5 mm diametro, ramis paucis, elongatis, adpresse strigoso-hirsutis; foliis chartaceis, fragilis, olivaceis, lanceolatis, usque ad 9 cm longis, tenuiter caudato-acuminatis, basi inaequilateralibus, acutis, margine subgrosse serratis, supra glabris, olivaceis, cystolithis numerosis instructis; nervis utrinque 5 ad 9, subtus valde perspicuis et adpresse strigoso-hirsutis; inflorescentiis ♂ axillaribus, sessilibus, 4 ad 5 mm diametro, bracteis liberis, exterioribus orbicularibus, rotundatis, leviter ciliatis, 3.5 mm longis, bracteolis spatulatis; floribus numerosis, 4-meris, segmentis oblongis ad ellipticis, 1.5 mm longis, haud corniculatis.

An erect, branched, woody plant up to 80 cm high, the stems terete, 4 to 5 mm in diameter, olivaceous when dry, the epidermis supplied with very numerous cystoliths, the branches few, elongated, up to 20 cm in length, the branchlets terete, appressed-strigose-hirsute, olivaceous. Leaves chartaceous, lanceolate, 5 to 9 cm long, 1.2 to 2.5 cm wide, brittle when dry, olivaceous, inequilateral, the base acute on both sides, one side longer and broader than the other, the apex slender, caudate-acuminate, the margins rather coarsely serrate except near the base, the upper surface olivaceous, densely covered with numerous, irregularly disposed cystoliths which are distinctly visible to the naked eye, the lower surface slightly paler than the upper, the midrib, marginal and lateral nerves very prominent, the lateral nerves 5 to 9 on each side of the midrib, anastomosing directly with the more or less arched marginal nerves, the cystoliths chiefly confined to the midrib, nerves, and reticulations, the midrib and primary nerves more or less appressed-strigose-hirsute; stipules lanceolate, acuminate, 3.5 mm long. Staminate inflorescences axillary, solitary or in pairs, sessile, 4 to 5 mm in diameter. Outer bracts orbicular, free or nearly so, 3.5 mm long, rounded, slightly ciliate; bracteoles spatulate, about 2 mm long, more or less ciliate above. Flowers numerous, 4-merous, the perianth segments oblong to elliptic, about 1.5 mm long, slightly ciliate at the apex, acute, two of them slightly cucullate, none spurred.

LUZON, Benguet Subprovince, near Baguio, *Merrill 9697*, May, 1914. In shaded places about limestone bowlders, altitude about 1,400 meters.

In vegetative characters this species somewhat resembles *Elatostema contiguum* C. B. Rob., but differs remarkably in its habit, being a much taller, strictly erect, branched plant, the stems being decidedly woody.

ELATOSTEMA SAMARENSE sp. nov.

Herba succulenta, parce ramosa, usque ad 50 cm alta, in siccitate pallide flavido-viridis, ramis parce ciliatis; foliis chartaceis, leviter inaequilateralibus, oblanceolatis, 6 ad 11 cm longis, tenuiter acuminatis, margine perspicue serratis, supra cystolithis numerosis instructis, scabris, foliis junioribus plus minusve ciliatis; nervis utrinque 4 ad 6, supra impressis, subtus valde perspicuis; stipulis anguste lanceolatis, circiter 1 cm longis; inflorescentiis ♀ axillaribus, sessilibus, solitariis, 5 ad 10 mm diametro, bracteis connatis, lobis paucis, oblongis, 1.7 mm longis, ciliatis, bracteolis anguste oblongis, 2 mm longis; floribus numerosis, acheniis oblongis, brunneis, cylindraceis, 0.8 mm longis.

An erect, sparingly branched, succulent herb, about 50 cm high, pale greenish yellow when dry, the stem glabrous with numerous cystoliths, the branches with scattered, spreading, elongated, weak, white hairs. Leaves chartaceous when dry, somewhat inequilateral, oblanceolate, 6 to 11 cm long, 2 to 3 cm wide, the apex slenderly acuminate, the base somewhat inequilateral, acute on the narrower side, obtuse on the broader side, the margins rather conspicuously serrate except near the base, the upper surface with numerous cystoliths, scabrous, the younger leaves with numerous, spreading, elongated, weak hairs from swollen bases, the swollen bases persisting on the older leaves causing the surface to be distinctly scabrous, the lower surface of the same color as the upper with equally distinct cystoliths, the midrib and nerves with scattered, conspicuous, spreading, white hairs; lateral nerves 4 to 6 on each side of the midrib, impressed on the upper surface, very prominent on the lower surface, arched-anastomosing; stipules narrowly lanceolate, acuminate, somewhat ciliate, about 1 cm long. Pistillate inflorescences axillary, sessile, 5 to 10 mm in diameter, flattened, irregular, the bracts connate, forming an irregularly lobed receptacle about 6 mm in diameter, the lobes rather few, oblong, 1.7 mm long, ciliate; bracteoles very numerous, narrowly oblong, 2 mm long,

ciliate. Flowers very numerous, the achenes oblong, 0.8 mm long, brown, cylindric.

SAMAR, Catubig River, *Bur. Sci. 34117 Ramos,* February, 1916. In damp forests at low altitudes.

This species is perhaps as closely allied to *Elatostema baruringense* Elm. as to any other species, but differs radically in numerous characters. It is at once distinguishable from the above species in its scabrous leaves and in the type of its hairs, Elmer's species having softly pubescent leaves.

PIPTURUS Weddell

PIPTURUS ANGUSTIFOLIUS sp. nov.

Frutex dioicus, 2 ad 3 m high, ramis rubro-brunneis, hirsutis; foliis coriaceis, rigidis, lanceolatis, in siccitate pallidis, 5 ad 9 cm longis, 1.3 ad 2 cm latis, tenuiter acuminatis, basi obtusis, 3-nervis, margine crenato-dentatis, utrinque scabridis, subtus dense cinereo-puberulis et ad costa nervisque adpresse strigoso-hirsutis, nervis utrinque 2 vel 3; floribus ♀ capitulato-fasciculatis, fasciculis spicatim dispositis, spicis 1 ad 2 cm longis, axillaribus, fasciculis 3 ad 5, 3 ad 4 mm diametro; acheniis ovoideis, 1 mm longis, breviter ferrugineo-pubescentibus.

A dioecious shrub, 2 to 3 m high, the branches and branchlets dark reddish-brown, more or less hirsute with short, stiff, pale hairs. Leaves coriaceous, rigid, brittle, lanceolate, pale when dry, 5 to 9 cm long, 1.3 to 2 cm wide, narrowed upward to the rather slenderly acuminate apex, the base obtuse, the margins crenate-dentate, the upper surface scabrid, sometimes with a very few scattered hairs, the lower surface paler than the upper, scabrid, the midrib, nerves, and reticulations appressed-strigose-hirsute and densely cinereous-puberulent on the surface; basal nerves 3, ascending, reaching to or beyond the middle of the leaf, the lateral nerves above the basal pair 2 or 3 on each side of the midrib, distinct, as are the reticulations; petioles 5 to 10 mm long, densely cinereous-hirsute; stipules lanceolate, acuminate, deciduous, about 5 mm long. Female flowers in spicately arranged fascicles, the spikes axillary, solitary, 1 to 2 cm long, the fascicles 3 to 5 on each spike, glabrous, dense, many-flowered, 3 to 4 mm in diameter; bracts lanceolate to obovate-lanceolate, acuminate, 2 to 3 mm long. Flowers numerous, crowded, sessile. Achenes ovoid, 1 mm long, ferruginous-pubescent with short hairs; styles 1.5 to 2 mm long, deciduous, pubescent.

LEYTE, Dagami, *Bur. Sci. 15320 Ramos,* August 6, 1912. In thickets along streams at low altitudes.

The alliance of this species is manifestly with *Pipturus argenteus* Wedd., from which it is readily distinguishable by its unusually narrow, lanceolate leaves.

POLYCHROA Loureiro

(*Pellionia* Gaudichaud)

POLYCHROA MULTINERVIA sp. nov.

Suffruticosa, erecta vel subscandens, usque ad 50 cm alta, partibus junioribus et subtus foliis ferrugineo-pubescentibus; foliis membranaceis, lanceolatis, aequilateralibus, 15 ad 20 cm longis, tenuiter acuminatis, basi obtusis, margine grosse et regulariter dentatis, nervis utrinque circiter 30, perspicuis; cymis axillaribus, parvis, circiter 1 cm diametro; floribus ♀ 5-meris, sepalis omnibus corniculatis, sub anthesin 3 mm longis, accrescentibus et sub fructu 6 mm longis, partibus inferioribus ellipticis; staminoideis sub fructu valde incrassatis.

An erect or somewhat scandent simple suffrutescent plant up to 50 cm high, the younger parts and the nerves and midribs on the lower surface of the leaves distinctly ferruginous-pubescent. Stems somewhat woody, terete, brown when dry, 2 to 2.5 mm in diameter, the younger parts somewhat sulcate or angled. Leaves membranaceous, lanceolate, 15 to 20 cm long, 2.5 to 4 cm wide, equilateral, the base usually obtuse, gradually narrowed upward to the slenderly acuminate apex, the margins coarsely dentate except at the very base, the teeth 5 to 8 mm apart, the upper surface olivaceous, shining, glabrous, smooth, minutely and densely pitted, the pits very shallow, cystoliths entirely wanting; lateral nerves about 30 on each side of the midrib, very distinct on the lower surface, the reticulations lax; petioles ferruginous-pubescent, 5 to 8 mm long; stipules lanceolate, acuminate, glabrous, brown, about 1 cm long. Cymes axillary, solitary, rather dense, about 1 cm in diameter, their peduncles up to 5 mm long, the pedicels less than 1 mm long. Female flowers, in anthesis, 3 mm long, green. Sepals 5, the basal part elliptic, about 1 mm long, somewhat cucullate, all spurred from the back, the spurs slender, about 2 mm long. The sepals in fruit accrescent and including the spur up to 6 mm in length, the spur obscurely ciliate. Staminodes in fruit much thickened, obovate, somewhat 4-angled, truncate, about 1 mm long, and 0.8 mm wide. Achene elliptic-ovate, somewhat compressed, about 2 mm long.

MINDANAO, Bukidnon Subprovince, near Tankulan, *Bur. Sci. 39137 Ramos & Edaño* July 5, 1920. On trees in damp forests at an altitude of about 900 meters.

A very strongly marked species and recognizable by its indumentum and its long, lanceolate, slender, acuminate, equilateral, and coarsely and regularly toothed leaves.

POLYCHROA FERRUGINEA sp. nov.

Frutex vel suffrutex scandens, ramosus, usque ad 50 cm altus, partibus junioribus et subtus foliis ferrugineo-pubescentibus; foliis membranaceis, oblongo-ellipticis ad oblongo-obovatis, 8 ad 14 cm longis, tenuiter acuminatis, basi inaequilateralibus, margine grosse crenatis vel crenato-serratis, nervis utrinque 8 ad 10, perspicuis; cymis axillaribus, circiter 1 cm longis, sublaxis; floribus ♀ 5-meris, sepalis oblongis, 3 mm longis, cucullatis, omnibus corniculatis, accrescentibus, sub fructu 6 mm longis; staminoideis valde incrassatis.

A slender, scandent, more or less branched, somewhat woody vine up to 50 cm long, the stems brown, glabrous or nearly so, terete, the younger parts ferruginous-pubescent with crisped hairs, more or less angled or compressed. Leaves alternate, membranaceous, oblong-elliptic to oblong-obovate, 8 to 14 cm long, 3.5 to 5 cm wide, the apex slenderly acuminate, the base distinctly inequilateral, obtuse, the margins rather coarsely crenate or crenate-serrate, the upper surface olivaceous, shining, usually with numerous short scattered cystoliths, the lower surface brownish and ferruginous-pubescent with crisped hairs on the midrib and lateral nerves, the indumentum less conspicuous on the surface; lateral nerves 8 to 10 on each side of the midrib, rather prominent on the lower surface, slightly curved, the reticulations not prominent; petioles pubescent, 5 to 7 mm long. Cymes axillary, solitary, about 1 cm long, 1 to 1.5 cm wide, shortly peduncled, rather lax, glabrous or slightly pubescent. Female flowers 5-merous, the sepals oblong, 3 mm long, more or less cucullate, all extended into a slender, 3 mm long, acuminate spur, the total length approximating 6 mm in fruit. Achene subellipsoid, about 2 mm long. Staminodes in fruit oblong, much thickened, 4-angled, truncate, about 1 mm long.

MINDANAO, Bukidnon Subprovince, Mount Candoon, *Bur. Sci. 38781 Ramos & Edaño,* July 27, 1920. In forests, altitude about 1,000 meters.

The alliance of this species is manifestly with Polychroa sinuata (Blume) (*Procris sinuata* Blume), from which it is distinguished especially by its ferruginous indumentum.

The generic name *Polychroa* Loureiro which dates from 1790 is here adopted in the place of *Pellionia* Gaudich. which dates from 1826. The two are congeneric, the type of Loureiro's genus being *Polychroa repens* Lour., with which the much more recently described *Pellionia daveauana* N. E. Br. (1880) is identical.

MENISPERMACEAE

PYCNARRHENA Miers

PYCNARRHENA MEMBRANIFOLIA sp. nov.

Frutex scandens, inflorescentiis minute pubescentibus exceptis glaber; foliis membranaceis, oblongis, 9 ad 12 cm longis, in siccitate atro-olivaceis, nitidis, tenuiter acuminatis, basi acutis, nervis utrinque 5 vel 6, tenuibus, petiolo 1 ad 2 cm longo; inflorescentiis ♂ cymosis, cymis fasciculatis, e caulis vetustioribus, tenuiter pedunculatis, paucifloris, circiter 3 cm longis, sepalis interioribus 3 vel 4 majoribus, incrassatis, obovatis, rotundatis, concavis, 2.3 mm longis, petalis 3, orbicularis ad obovatis, 1 mm diametro; staminibus circiter 6, obovoideis ad anguste obovoideis, 0.8 mm longis.

A woody vine, glabrous except for the minutely pubescent inflorescences, the branches terete, about 8 mm in diameter, brownish, the leaf-bearing branchlets about 2 mm in diameter, these sometimes solitary, sometimes fascicled. Leaves membranaceous, oblong, dark olivaceous when dry, shining, 9 to 12 cm long, 3 to 4.5 cm wide, slenderly acuminate, base acute; lateral nerves 5 or 6 on each side of the midrib, distant, slender but distinct, anastomosing; petioles 1 to 2 cm long. Staminate inflorescences fascicled on tubercles along the main stems or leafless branches, the cymes about 3 cm long, slenderly peduncled, few-flowered, obscurely pubescent. Flowers yellow, black when dry, their pedicels 4 to 7 mm long, the external sepals small, slightly pubescent, ovate, acuminate, less than 1 mm in length, the next 3 or 4 larger, thickened, obovate, rounded, concave, glabrous, about 2.3 mm long, imbricate. Petals 3, orbicular to obovate, glabrous, about 1 mm in diameter. Stamens 6, narrowly obovoid, 0.8 mm long.

MINDANAO, Zamboanga District, Malangas, *Bur. Sci. 37536 Ramos & Edaño,* October 26, 1919. In forests at low altitudes, locally known as *dalupat.*

This species is radically different from known Philippine representatives of the genus both in its membranaceous leaves and in its lax, few-flowered, slenderly peduncled inflorescences. It is apparently most closely allied to *Pycnarrhena cauliflora* Diels, but differs from that species in numerous characters, especially in its smaller leaves which are acute at the base and slenderly acuminate at the apex, with fewer nerves than in Diels's species. The number cited above was distributed under the generic name *Fibruarea.*

ANONACEAE

GONIOTHALAMUS Hooker f. and Thomson

GONIOTHALAMUS PUNCTICULIFOLIUS sp. nov.

Frutex vel arbor parva, ramis tenuibus, glabris, ramulis leviter adpresse cupreo-pubescentibus; foliis chartaceis, anguste oblongis, 8 ad 12 cm longis, nitidis, glabris vel subtus ad costa leviter pubescentibus, acutis vel leviter acuminatis, basi acutis, subtus minutissime rubro-puncticulatis, nervis utrinque circiter 10, tenuibus, reticulis laxis, obscuris; floribus axillaribus, solitariis, circiter 2 cm longis; sepalis late ovatis, 6 mm longis, leviter cupreo-pubescentibus; petalis valde incrassatis, utrinque pubescentibus, exterioribus 2 cm longis, oblongo-ovatis ad oblongo-lanceolatis, acutis, interioribus conniventibus, oblongo-ovatis, 1.5 cm longis, acutis; carpellis circiter 12, pubescentibus, stylis glabris, quam carpellis duplo longioribus; ovulis paucis.

A subglabrous shrub or small tree, the branches terete, slender, rugose, dark-colored when dry, the very young branchlets and buds sparingly appressed-pubescent with cupreous hairs. Leaves chartaceous, narrowly oblong, 8 to 12 cm long, 2 to 3 cm wide, the upper surface pale-olivaceous, strongly shining, smooth, the lower surface somewhat paler, minutely reddish-puncticulate, glabrous on both surfaces or the midrib beneath sparingly appressed-pubescent, the apex acute to slightly acuminate, the base acute; lateral nerves slender, about 10 on each side of the midrib, not prominent, arched-anastomosing, the reticulations lax, indistinct; petioles about 5 mm long, the younger ones sparingly cupreous-pubescent, in age glabrous. Flowers axillary, solitary, about 2 cm long, yellow, slightly fragrant, their pedicels 1 cm long or less, appressed cupreous-pubescent, subtended by 2 or 3 ovate, obtuse, pubescent, 2-mm long bracts. Sepals broadly ovate, acute to obtuse, about 6 mm long, reticulate in transmitted light, sparingly cupreous-

pubescent. Outer three petals oblong-ovate to oblong-lanceolate, very thick, pubescent on both surfaces, the indumentum soft, cinereous to ferruginous, rather dense on the inner surface, about 2 cm long, 7 to 10 mm wide, narrowed upward to the acute apex; inner three petals connivent, forming a cone surrounding the stamens, oblong-ovate, acute, thickened, pubescent, about 1.5 cm long and 9 mm wide. Stamens indefinite, 2 mm long, truncate. Carpels about 12, oblong-ovoid, 2 mm long, appressed-pubescent, narrowed upward; styles glabrous, twice as long as the carpels; ovules few.

MINDORO, Paluan, *Bur. Sci. 39660* (type), *39519, 39676 Ramos*, April, 1921. In dry forests at low altitudes.

A species in vegetative characters somewhat resembling *Goniothalamus amuyon* (Blanco) Merr., but differing radically in its floral characters. It is well characterized by its minutely puncticulate leaves and its elongated styles.

LAURACEAE

CRYPTOCARYA R. Brown

CRYPTOCARYA EDAÑOII sp. nov.

Arbor, ramulis et inflorescentiis et subtus foliis ad costa nervisque dense ferrugineo-villosis; foliis coriaceis, ovatis ad subellipticis, usque ad 17 cm longis et 12 cm latis, supra, costa excepta, glabris, subolivaceis, minutissime et obscure foveolatis, subtus glaucescentibus, basi plerumque latissime rotundatis, apice abrupte et brevissime apiculato-acuminatis; nervis et reticulis primariis supra impressis, subtus valde perspicuis, nervis utrinque circiter 10; paniculis usque ad 15 cm longis, ramis ramulisque crassis, densissime ferrugineo-villosis, fructibus junioribus oblongo-ellipsoideis, 12 mm longis, nigris, leviter ferrugineo-pubescentibus.

A tree, the branchlets and inflorescences very densely ferruginous-villous, the leaves ferruginous-villous beneath on the midrib, nerves, and reticulations. Ultimate branches up to 7 mm in diameter, pubescent. Leaves coriaceous, the normal ones ovate, those on the younger branchlets subelliptic, 13 to 17 cm long, 7 to 12 cm wide, the upper surface subolivaceous, somewhat shining, glabrous except for the pubescent midrib, minutely and shallowly foveolate, the midrib, nerves, and primary reticulations impressed, the lower surface somewhat glaucous, the midrib, nerves, and reticulations pale brownish, the base usually broadly rounded, the apex abruptly and shortly apiculate-acuminate;

lateral nerves about 10 on each side of the midrib, somewhat curved-anastomosing at the very margin, very prominent on the lower surface as are the reticulations; petioles densely pubescent, about 1 cm long. Panicles terminal, about 15 cm long and with smaller ones in the uppermost axils, all parts densely ferruginous-villous, the branches and branchlets few, thickened, the ultimate branchlets 2 to 3 mm in diameter. Immature fruits oblong-ellipsoid, black when dry, about 12 mm long, obscurely longitudinally sulcate, more or less ferruginous-villous, the indumentum apparently deciduous.

MINDANAO, Zamboanga District, Mount Tubuan, *Bur. Sci. 36706 Ramos & Edaño,* October, 1919. In forests at low altitudes.

CRYPTOCARYA CAGAYANENSIS sp. nov.

Arbor glabra (floribus ignotis); foliis oblongis, coriaceis, 20 ad 25 cm longis, supra olivaceis vel atro-olivaceis, nitidis, subtus glaucescentibus, nervis utrinque circiter 15, perspicuis, reticulis primariis subparallelis; paniculis terminalibus, sub fructu 10 ad 14 cm longis, fructibus ovoideis, 3 cm longis, supra angustatis, obtusis, in siccitate nigris.

A glabrous tree (flowers unknown), the ultimate branches about 4 mm in diameter, brownish or grayish, somewhat rugose and sulcate when dry. Leaves oblong, thickly coriaceous, 20 to 25 cm long, 5.5 to 8 cm wide, the apex shortly and obtusely acuminate, the base broadly acute, the upper surface dark-olivaceous, somewhat shining, smooth, the lower surface more or less glaucous, glabrous, not at all foveolate; lateral nerves about 15 on each side of the midrib, nearly straight, prominent on the lower surface, ascending at an angle of nearly 45°, anastomosing close to the margin, the primary reticulations slender, subparallel; petioles about 2 cm long. Fruiting panicles terminal, 10 to 14 cm long, the branches few, stout, glabrous. Fruits ovoid, narrowed upward to the blunt apex, about 3 cm long, 1.5 to 1.8 cm in diameter, dark brown or nearly black when dry, glabrous, obscurely longitudinally ridged or nearly smooth.

LUZON, Cagayan Province, *For. Bur. 28440 Ponce,* May, 1921. Apparently growing in forests at low altitudes.

A species strongly characterized by its thickly coriaceous, oblong leaves, which are somewhat glaucous beneath, and especially by its unusually large, ovoid fruits, which are about 3 cm in length, rather abruptly narrowed at the base and gradually narrowed upward to the obtuse apex.

LITSEA Lamarck

LITSEA ODORIFERA Valeton in Ic. Bogor. 3 (1909) *t. 276.*

PALAWAN, Puguiauan, *For. Bur. 27884 Cenabre, Baldemor, & Aduviso,* February 5, 1920. On forested ridges, altitude 150 meters, with the Tagbanua name *magtagbak.* Sumatra, Java (introduced), Borneo.

ROSACEAE

RUBUS Linnaeus

RUBUS PERFULVUS sp. nov. § *Malachobatus, Moluccani, Rugosi.*

Species R. rolfei affinis differt foliis minoribus, haud lobatis, basi truncatis, haud cordatis, subtus vix foveolatis.

A scandent shrub, the branches glabrous, reddish-brown, aculeate, the aculeae 1 mm long or less, slightly curved, the branchlets densely fulvous-tomentose. Leaves coriaceous, ovate, 6 to 9 cm long, 4 to 7 cm wide, shortly acuminate, base broadly truncate, irregularly toothed, not lobed, the upper surface dark olivaceous brown, glabrous, or when young more or less ciliate-pilose, shining, somewhat rugose, the lower surface very densely fulvous-tomentose, the indumentum obscuring all but the primary reticulations, the midrib and nerves with scattered small spines hidden in the indumentum, base 3-nerved, the primary lateral nerves above the basal pair usually 4 on each side of the midrib, prominent; petioles about 1 cm long, densely fulvous-tomentose and retrorsely aculeate, the aculeae hidden in the indumentum; stipules free, narrowly oblong, entire, deciduous, about 1.5 cm long, 3 mm wide, outside densely tomentose, inside glabrous. Inflorescences terminal, about 5-flowered, the flowers somewhat crowded, large, about 5 in each raceme, often solitary flowers also in the upper axils, the pedicels densely tomentose, 1 cm long or less. Calyx about 13 mm long, the lobes lanceolate, acuminate, densely fulvous-tomentose. Achenes about 3 mm long, somewhat rugose, glabrous, strongly ventricose-curved, the styles about 5 mm long. Fruit red when mature.

MINDANAO, Bukidnon Subprovince, Mount Lipa, *Bur. Sci. 38566 Ramos & Edaño,* July, 1920. In the mossy forest, altitude about 2,000 meters.

A very distinct species, among the hitherto described forms most closely allied to *Rubus rolfei* Vid. but very different from that species in its vegetative characters.

RUBUS HETEROSEPALUS sp. nov. § *Malachobatus, Moluccani.*

Frutex scandens, ramis et ramulis et subtus foliis densissime subfulvo-tomentosis aculeatisque; foliis suborbicularibus, coriaceis, 5-lobatis, 12 ad 15 cm longis, basi cordatis, apice acutis vel leviter acuminatis, supra rugosis, olivaceis, petiolo 3.5 ad 5 cm longo; stipulis deciduis, liberis, laciniatis: inflorescentiis terminalibus, paniculatis, 15 ad 20 cm longis; floribus confertis, magnis, calycibus 3.5 cm diametro; sepalis 2 lanceolatis, circiter 5 mm latis, acuminatis, integris, 3 obovatis, profunde laciniatis, 10 ad 14 mm latis: bracteolis obovatis, circiter 15 mm longis, usque ad ½ laciniatis, laciniae circiter 15, lineari-lanceolatae.

Scandent, woody, the branches, petioles, and lower surface of the leaves very densely and uniformly tomentose with brownish to fulvous hairs, the branches, branchlets, petioles, midribs, and primary nerves on the lower surface supplied with numerous, rather slender, slightly curved spines, 1.5 to 3 mm in length. Leaves simple, orbicular-ovate in outline, coriaceous, distinctly 5-lobed, the sinuses rather shallow, apex acute or slightly acuminate, base rather deeply cordate, 12 to 15 cm long, 11 to 13 cm wide, the upper surface olivaceous, rugose, the midrib and primary nerves rather densely hirsute, the surface with scattered, similar indumentum; petioles 3.5 to 5 cm long; stipules deciduous, densely pubescent, free, 10 to 14 mm long, laciniate. Inflorescences terminal, 15 to 20 cm long, paniculate, the lower branches about 7 cm long, all parts densely pubescent, the rachis and branches aculeate. Flowers numerous, crowded, the subtending bracteoles obovate, about 15 mm long and wide, divided nearly to the midrib into about 15 linear-lanceolate laciniae. Calyx when spread about 3.5 cm in diameter, the sepals all densely pubescent, two narrow, lanceolate, acuminate, entire, about 1.5 cm long, 5 mm wide below; three obovate, deeply laciniate, about 18 mm long, 10 to 14 mm wide. Petals not seen. Stamens numerous, about 5 mm long, glabrous. Fruit red, the achenes numerous, inequilateral, obovoid, about 4 mm long; style about 5 mm long.

LUZON, Bontoc Subprovince, Mount Polis, *Bur. Sci. 37609 Ramos & Edaño,* February 25, 1920. In the mossy forest, altitude about 1,800 meters, with the local name *tukong.*

This was originally identified as *Rubus rolfei* Vid., but is remarkably distinct from that species and from all other described forms in its calyx characters. It resembles Vidal's

species, but is at once distinguished by its aculeate branches, petioles, and leaves, as well as by its rather larger paniculate inflorescences. The most striking character of the present species is found, however, in the sepals which are remarkably dissimilar, two being narrowly lanceolate and entire, the other three being obovate and deeply laciniate.

LEGUMINOSAE

CASSIA Linnaeus

CASSIA MINDANAENSIS sp. nov. § *Chamaecrista, Leiocalyx, Subcoriaceae.*

Arbor circiter 5 m alta, partibus junioribus leviter adpresse pubescentibus, ramulis circiter 2 mm diametro; foliis 7 ad 10 cm longis, foliolis 20 ad 28, subcoriaceis, inaequilateralibus, oblongis, 1 ad 1.5 cm longis, obtusis apiculatisque, basi rotundatis, glabris, nitidis; floribus supra-axillaribus, fasciculatis vel racemosis, pedicellatis circiter 2 cm diametro, sepalis lanceolatis ad elliptico-lanceolatis, acute acuminatis, 8 mm longis, petalis obovatis, rotundatis, basi cuneatis; leguminis circiter 3 cm longis, 6 mm latis, subglabris, seminibus 3 vel 4.

A tree about 5 m high, the young parts somewhat appressed-pubescent. Branches about 2 mm in diameter, brown, terete, slightly pubescent, ultimately glabrous. Leaves 7 to 10 cm long, the rachis slightly pubescent and with a single conspicuous gland halfway between the lower pair of leaflets and the base of the petiole; leaflets 20 to 28, subcoriaceous, inequilateral, sessile, subolivaceous, ultimately glabrous, the apex obtuse and minutely apiculate, the base rounded, the midrib situated in about the upper one-third of the leaf, the lateral nerves ascending, slender, about 6 on each side of the midrib; stipules linear-lanceolate, acuminate, 3 mm long. Flowers yellow, about 2 cm in diameter, in few-flowered, supra-axillary fascicles or the lower inflorescences racemose, the rachis produced about 5 mm, the inflorescences usually in pairs; bracts about 2 mm long, abruptly linear-lanceolate, and acuminate from a broad base; bracteoles 2, near the apex of the pedicels, linear-lanceolate, acuminate, 2 to 2.5 mm long. Sepals lanceolate to elliptic-lanceolate, sparingly appressed-pubescent, acutely acuminate, about 8 mm long. Petals obovate, 10 mm long, 7 to 8 mm wide, rounded, base cuneate, glabrous. Anthers 4 to 5 mm long, their filaments 1 mm long or less. Ovary and style about 10 mm long, the former appressed-pubescent, about 5-ovulate. Pods thin, narrowly oblong, oblique at both base and apex, slightly

acuminate, sparingly pubescent, obscurely reticulate, about 3 cm long, 6 mm wide, usually with 3 or 4 seeds.

MINDANAO, Davao District, Mount Bulan, *For. Bur. 28245 Mataya,* November 23, 1920. Along banks of streams at an altitude of about 40 meters.

This species rather strongly resembles *Cassia polyadenia* DC. of tropical America and is manifestly allied to it, although differing in numerous details.

MUCUNA Adanson

MUCUNA FOVEOLATA sp. nov. § *Zoopthalmum, Citta.*

Frutex scandens, partibus junioribus plus minusve adpresse cinereo-pubescentibus, ramulis tenuibus; foliolis membranaceis, ovatis, acuminatis, olivaceis, nitidis, 10 ad 15 cm longis, subtus parce pubescentibus, stipellis linearis, usque ad 5 mm longis; inflorescentiis longissime pedunculatis, pendulis, pedunculo usque ad 80 cm longo, glabro; calycis persistentibus, cinereo-pubescentibus et pilis urentibus instructis; fructibus oblongis, plus minusve ferrugineo-hirsutis, 20 ad 24 cm longis, 5 ad 6 cm latis, 15 cm crassis, apice abrupte et tenuiter acuminatis, profunde foveolatis, foveolis numerosis, rotundatis ad oblongis, 0.5 ad 1.5 cm longis, haud oblique dispositis.

A more or less woody vine, the branches terete, glabrous, reddish-brown or brown when dry, the branchlets slender, nearly black when dry, sparingly pubescent with appressed-cinereous hairs. Petioles 6 to 10 cm long, slightly cinereous-pubescent; stipules narrowly lanceolate, about 3 mm long; leaflets membranaceous, ovate, dark olivaceous when dry, somewhat shining, 10 to 15 cm long, 6 to 8 cm wide, slenderly acuminate, slightly pubescent on the upper surface, ultimately glabrous, the lower surface sparingly pubescent, the terminal one equilateral and subacute at the base, the lateral ones inequilateral, rounded to subacute; stipels linear, up to 5 mm long. Flowers unknown. Peduncles of the infructescences pendulous, up to 80 cm long, glabrous or nearly so. Persistent calyces cinereous-pubescent with long, scattered, appressed, rigid, brown hairs, the tube about 12 mm long, the lobes lanceolate, acuminate, up to 1 cm long. Pods oblong, flattened, 20 to 24 cm long, 5 to 6 cm wide, about 1.5 cm thick, the base subacute, the apex abruptly and slenderly acuminate, the acumen about 1.5 cm long, when young more or less ferruginous-hirsute, at full maturity nearly glabrous, both surfaces irregularly and deeply foveolate throughout, the foveolae rounded to

oblong, 0.5 to 1.5 cm long, up to 1 cm deep. Seeds about 6, flattened, nearly black when dry, orbicular, about 22 mm in diameter.

LUZON, Tayabas Province, Kabibihan, *For. Bur. 28379 Mabesa* (type), June, 1918. SAMAR, Tinani, *For. Bur. 21048 Sherfesee, Cenabre, & Cortez,* April, 1914. On river banks and along the edges of secondary forests from sea level to an altitude of 200 meters; locally known in Samar as *danipai.*

A remarkably distinct species characterized by its very long-peduncled infructescences and its elongated pods which are not transversely plicate, but very deeply and irregularly foveolate; the central foveolae are mostly rounded or angular in outline, the marginal ones more or less elongated transversely. The species is manifestly allied to *Mucuna nigricans* DC., but is at once distinguishable by its fruit characters.

MUCUNA SAMARENSIS sp. nov.

Frutex scandens, partibus junioribus plus minusve cinereo-hirsutis, inflorescentiis cinereo-pubescentibus et pilis ferrugineis urentibus instructis; foliolis glabris, membranaceis, 11 ad 13 cm longis, oblongo-ovatis ad oblongo-lanceolatis, tenuiter obtuse acuminatis, stipellis linearis, 3 mm longis; inflorescentiis usque ad 40 cm longis, pedunculo 15 cm longo, ramis paucis, usque ad 22 cm longis; floribus atro-purpureis, 6.5 cm longis, pedicellis usque ad 3 cm longis, bracteis oblongo-ellipticis, membranaceis, acuminatis, cinereo-pubescentibus, 3 cm longis et 12 mm latis, bracteolis minoribus, 2.5 cm longis, 8 mm latis, deciduis; calycis late cupulatis, cinereo-pubescentibus, pilis urentibus instructis; petalis glabris; ovario oblongo, 10 mm longo, dense hirsuto.

A more or less woody vine, the younger parts more or less hirsute with appressed-cinereous hairs, the inflorescences cinereous-pubescent and supplied with scattered, stiff, brown, stinging hairs, the branchlets nearly black when dry, about 2 mm in diameter. Petioles 6 to 8 cm long; stipules narrowly lanceolate, about 3 mm long. Leaflets membranaceous, oblong-ovate to oblong-lanceolate, olivaceous, shining, glabrous, 11 to 13 cm long, 4.5 to 6 cm wide, rather slenderly but obtusely acuminate, the terminal ones equilateral, obtuse at the base, the lateral ones distinctly inequilateral and rounded; stipels linear, 3 mm long. Inflorescences up to 40 cm long, the peduncles about 15 cm long, the branches few, 20 to 22 cm long. Flowers purplish-black when dry, about 6.5 cm long, the pedicels

in anthesis about 3 cm long, the buds subsessile or shortly pediceled. Each flower is subtended by an oblong-elliptic, membranaceous, cinereous-pubescent bract which is supplied also with few, scattered, stinging, brown hairs, and is about 3 cm long and 12 mm wide, and by two similar but smaller bracteoles about 2.5 cm long and 8 mm wide, the bracts and bracteoles deciduous. Calyx broadly cup-shaped, cinereous-pubescent with numerous, brown, stinging hairs, the tube about 1 cm long, the upper lobe broadly ovate, obtuse, 4 to 5 mm long, the lower lip 3-lobed, the lobes narrowly lanceolate, acuminate, the two lateral ones 5 to 7 mm long, the middle one up to 1 cm in length. Standard oblong-ovate, obtuse, 4 cm long, 2 cm wide, glabrous; wings oblong, obtuse, 7 cm long, 1.5 cm wide, shortly clawed, the basal auricle oblong, obtuse, 2.5 mm long, somewhat pubescent near the base; keel equaling the wings, 1 cm wide (folded), slightly curved above, acute. Stamens glabrous, all parts free; filaments about 10 mm long. Ovary oblong, 10 mm long, densely hirsute with long hairs; style appressed-hirsute.

SAMAR, Catubig River, *Bur. Sci. 24341 Ramos*, February, 1916. In damp forests along the margins of old clearings at low altitudes; locally known as *malanipai*.

This species belongs in the section *Zoopthalmum* and probably in the subsection *Citta*, although fruiting material is necessary to verify this. Striking characters are its membranaceous, glabrous leaflets; its short-peduncled infructescences; its membranaceous, conspicuous, deciduous bracts and bracteoles; and its purplish-black flowers.

RUTACEAE

EVODIA Forster

EVODIA CONFUSA sp. nov.

Evodia glabra F.-Vill. Novis. App. (1880) 34; Vidal Rev. Pl. Vasc. Filip. (1886) 74; Merr. in Philip. Journ. Sci. 1 (1906) Suppl. 68, Sp. Blancoanae (1918) 293, non Blume.

Arbor 5 ad 10 m alta, inflorescentiis exceptis glabra; ramulis incrassatis; foliis 3-foliolatis, foliolis oblongo-ellipticis ad obovatis, coriaceis vel subcoriaceis, nitidis, 15 ad 25 cm longis, breviter acuminatis, basi acutis, subtus punctatis, nervis utrinque 12 ad 15, perspicuis; cymis axillaribus, 10 ad 15 cm longis, usque ad 15 cm latis, pedunculatis, multifloris; floribus albidis; fructibus circiter 1 cm diametro, 4-coccis, coccis subovoideis, leviter compressis.

A tree, 5 to 10 m high, glabrous or nearly so except the cinereous-pubescent inflorescences. Branches usually grayish, the branchlets stout, more or less compressed. Leaves 3-foliolate, their petioles 5 to 10 cm long; leaflets coriaceous or subcoriaceous, in general oblong-elliptic to obovate, 15 to 25 cm long, 6 to 12 cm wide, apex somewhat acuminate, base acute, shining, lower surface punctate, both surfaces usually greenish-olivaceous when dry; lateral nerves 12 to 15 on each side of the midrib, prominent; petiolules 0.5 to 1.5 cm long. Inflorescences axillary, peduncled, many-flowered, more or less cinereous-pubescent, 10 to 15 cm long, up to 15 cm wide, the peduncles 3 to 9 cm long. Flowers white, their pedicels 2 to 3 mm long, slightly pubescent. Sepals 4, oblong to obovate, obtuse, somewhat pubescent, about 1 mm long. Petals elliptic, glabrous, 2.5 mm long. Stamens 4; filaments 3 mm long. Fruits about 1 cm in diameter, of 4 subovoid, somewhat compressed cocci.

This species, long confused with *Evodia glabra* Blume, chiefly on account of the erroneous identification of *Cuming 1745* with Blume's species, is found from northern Luzon to Mindanao, and apparently also in Celebes (*Koorders 18758*, erroneously identified as *Evodia minahassae* Teysm. & Binn.). It is represented by very numerous specimens, as follows:

LUZON, Cagayan Province, *For. Bur. 23311, 24850 Velasco, 11267 Klemme, 17052 Curran, Bur. Sci. 7501 Ramos:* Bontoc Subprovince, *Bur. Sci. 18399 Alvarez:* Bataan Province, *For. Bur. 24190 Alambra & Bawan, 2947, 3045 Borden:* Rizal Province, *Merrill 1887, 1672, 3832, Sp. Blancoanae 904, For. Bur. 3072 Ahern's collector, Loher 5146:* Laguna Province, *For. Bur. 25686 Amarillas, 20407 Villamil, 22253 Mariano, Bur. Sci. 15055 Ramos* (type), *Elmer 17645a:* Tayabas Province, *Merrill 1109, For. Bur. 25555 Vargas, Whitford 664, For. Bur. 10487 Curran:* Camarines Province, *Bur. Sci. 33566 Ramos & Edaño, Merrill Phil. Pl. 1535, For. Bur. 21466, 23705, 23758 Alvarez, 25529 Cenabre, 24794 Lomuntad.* POLILLO, *Bur. Sci. 10326 McGregor, 9129, 9228 Robinson.* MINDORO, *Whitford 1448, Merrill 2369.* SAMAR, *For. Bur. 25766 Acuña & Madrid, Piper 363.* LEYTE, *Cuming 1745, Wenzel 154, 401, 694, Elmer 7375.* PANAY, *Bur. Sci. 31164 Ramos & Edaño, For. Bur. 23562 Vergara.* SIARGAO, *Bur. Sci. 34868, 35008 Ramos & Pascasio.* MINDANAO, Surigao Province, *Piper 332:* Zamboanga District, *Bur. Sci. 36999 Ramos & Edaño:* Agusan Subprovince,

Elmer 13519. Often common in forests at low and medium altitudes.

This species closely resembles material from the Malay Peninsula identified as *Evodia latifolia* DC. which I do not think can be referred to de Candolle's species which was based wholly on *Ampacus latifolia* Rumph. Herb. Amb. 2: 186, *t. 61*, a species with membranaceous pubescent leaves and in all probability identified with Miquel's conception of the species as redescribed by him from Halmahera specimens.[2] *Evodia glabra* Blume is remote from the present species and is identical with *E. aromatica* Blume, which in turn is scarcely distinct from *E. lunur-ankenda* (Gaertn.) Merr.

MELIACEAE

AGLAIA Loureiro

AGLAIA CUPREO-LEPIDOTA sp. nov. § *Euaglaia*.

Arbor parva, partibus junioribus dense cupreo-lepidotis, ramis glabris, lenticellatis, teretibus, ramulis ultimis 2 mm diametro; foliis 12 ad 17 cm longis, 5-foliolatis, alternis, foliolis chartaceis ad subcoriaceis, elliptico-ovatis, 5 ad 8 cm longis, breviter obtuse acuminatis, basi acuminatis vel acutis, supra glabris, pallide olivaceis, utrinque puncticulatis, subtus parcissime cupreo-lepidotis, vetustioribus glabris; paniculis axillaribus, dense cupreo-lepidotis, circiter 4 cm longis, petiolo subaequantibus; floribus racemose dispositis, 5-meris, calycis dense cupreo-lepidotis, lobis late ovatis, rotundatis, 1 mm diametro; petalis liberis, glabris, 2 mm longis; tubo glabro, cupulato, truncato, 1.2 mm diametro; antheris 5, inclusis.

A small tree, the younger parts densely cupreous-lepidote, the branches terete, glabrous, pale-brownish, somewhat lenticellate, the ultimate branchlets about 2 mm in diameter. Leaves pinnate, 12 to 17 cm long, 5-foliolate, the petioles and rachis lepidote; leaflets opposite, chartaceous to subcoriaceous, elliptic-ovate, pale-olivaceous and shining when dry, 5 to 8 cm long, 2.5 to 3.5 cm wide, the apex rather abruptly and obtusely acuminate, the base acuminate or acute, the upper surface smooth, glabrous, both surfaces minutely puncticulate, the lower surface sparingly cupreous-lepidote especially near the midrib and nerves, ultimately glabrous; lateral nerves about 7 on each side of the midrib, slender; petiolules lepidote, 5 to 10 mm long. Panicles axillary, solitary, about 4 cm long, branched from near

[2] Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 244.

the base, the lower branches up to 3 cm in length, spreading, all parts densely cupreous-lepidote. Flowers yellow, 5-merous, comparatively few, racemosely arranged on the ultimate branchlets, the buds obovoid, the pedicels 1 to 1.5 mm long. Calyx densely lepidote, the lobes 5, broadly ovate, rounded, 1 mm in diameter. Petals glabrous, free, ovate to elliptic-ovate, 2 mm long. Staminal tube free, glabrous, cup-shaped, 1.2 mm in diameter, truncate, the anthers 5, inserted below the rim, included.

MINDORO, Paluan, *Bur. Sci. 39579* (type), *39758 Ramos,* April, 1921. In dry primary forests at low altitudes.

In its puncticulate leaves this species resembles *Aglaia pyriformis* Merr. and *A. robinsonii* Merr., but is not at all allied to these species. Its true alliance appears to be with *Aglaia denticulata* Turcz., from which it is at once distinguished by its short panicles which do not exceed the petioles in length.

DICHAPETALACEAE

DICHAPETALUM Thouars

DICHAPETALUM EUPHLEBIUM sp. nov.

Frutex scandens, ramis glabris, lenticellatis, ramulis adpresse pubescentibus; foliis membranaceis vel chartaceis, viridis, nitidis, oblongis ad oblongo-ellipticis, 9 ad 13 cm longis, acuminatis, nervis utrinque 5 vel 6, subtus valde perspicuis; cymis axillaribus, brevibus, paucifloris, pedunculo 3 ad 5 mm longo; petalis oblongis, obtusis, 2 mm longis, integris; fructibus obovoideis, dense pubescentibus, apice leviter retusis.

A scandent shrub, the branches glabrous, lenticellate, the branchlets appressed-pubescent with short, dirty-brown hairs. Leaves membranaceous to chartaceous; oblong to oblong-elliptic, green when dry, somewhat shining, 9 to 13 cm long, 3 to 5 cm wide, the base acute to obtuse, the apex distinctly acuminate, the upper surface glabrous, the lower surface somewhat appressed-pubescent on the midrib and nerves, ultimately nearly glabrous; lateral nerves 5 or 6 on each side of the midrib, very prominent on the lower surface, curved-ascending, prominent, anastomosing, the reticulations lax, very distinct; petioles about 5 mm long, appressed-pubescent. Inflorescences axillary, solitary, cymose, few-flowered, the peduncles 3 to 5 mm long, appressed-pubescent, rather stout, the pedicels 1.5 to 2 mm long; bracteoles narrowly oblong to linear-oblong, up to 2 mm long. Sepals oblong to oblong-elliptic, obtuse, 2 mm long, pubescent. Petals glabrous, oblong, obtuse, not cleft at the apex, 2

mm long. Filaments 2 mm long, glabrous, base thick, attenuate upward. Immature fruits densely pubescent, obovoid, the apex somewhat retuse, about 8 mm long, normally 2-celled.

MINDANAO, Zamboanga District, Malangas and Mount Tubuan, *Bur. Sci. 37284* (type), *36702 Ramos & Edaño*, October, 1919. In secondary forests at low altitudes.

A species closely allied to *Dichapetalum holopetalum* Merr., from which it is distinguished especially by its glabrous, not ciliate branches, and otherwise by its scanty, very different indumentum, in the present species the nerves, branches, etc., being merely appressed-pubescent with short hairs, while in *Dichapetalum holopetalum* the hairs are elongated and spreading.

EUPHORBIACEAE

CROTON Linnaeus

CROTON LANCILIMBUS sp. nov.

Frutex circiter 1 m altus, partibus junioribus plus minusve lepidotis; foliis numerosis, anguste lanceolatis, membranaceis, 10 ad 15 cm longis, 1 ad 1.5 cm latis, in siccitate pallidis, basi plerumque cuneatis, apice tenuiter caudato-acuminatis, supra glabris, subtus minute stellato-lepidotis, nervis utrinque circiter 10, tenuibus, petiolo 3 ad 5 mm longo; infructescentiis tenuibus, circiter 4 cm longis, lepidotis, capsulis paucis, circiter 6 mm diametro, brunneo-lepidotis, stylis 3 mm longis, trifidis.

A shrub about 1 m high, the younger parts and the lower surface of the leaves more or less lepidote, branches terete, rather slender, glabrous, the branchlets rather densely lepidote with dark-brown, minute scales. Leaves narrowly lanceolate, membranaceous, 10 to 15 cm long, 1 to 1.5 cm wide, pale when dry, subequally narrowed to the cuneate or abruptly obtuse base and to the slenderly caudate-acuminate apex, the upper surface glabrous, shining, the lower surface supplied with scattered, minute, white, shining, stellate scales which are closely appressed to the surface; lateral nerves very slender, about 10 on each side of the midrib, distant, anastomosing; petioles 3 to 5 mm long, biglandular at the apex. Infructescences in the uppermost axils or terminal, simple, slender, about 4 cm long, lepidote, the capsules few, about 6 mm in diameter, brown-lepidote, the persistent styles about 3 mm long, trifid.

MINDANAO, Zamboanga District, Malangas, *Bur. Sci. 36855* (type), *37078 Ramos & Edaño*, October, 1919. Along the banks of rivers at low altitudes.

A species strongly characterized by its very narrow, slender, caudate-acuminate, thin leaves, which are supplied on the lower surface with rather numerous, scattered, white, shining, stellate scales which do not, however, form a continuous covering.

TRIGONOSTEMON Blume

TRIGONOSTEMON ANGUSTIFOLIUS sp. nov. § *Eutrigonostemon.*

Frutex dioicus, 1 ad 3 m altus, partibus junioribus plus minusve pubescentibus; foliis lanceolatis, integris, chartaceis, 12 ad 20 cm longis, 2.5 ad 4 cm latis, utrinque subaequaliter angustatis, basi plerumque cuneatis, apice tenuiter acuminatis, nervis utrinque 9 ad 11, subtus perspicuis, petiolo 5 ad 15 mm longo; inflorescentiis ♀ axillaribus, tenuibus, circiter 6 cm longis, spicatis vel subracemosis, bracteis lanceolatis, 8 ad 14 mm longis; floribus paucis, calycis eglandulosis, lobis lanceolatis, acuminatis, 6 mm longis, petalis oblongis, glabris, atro-purpureis, 5 ad 6 mm longis; capsulis depresso-globosis, 12 mm diametro, leviter adpresse pubescentibus, sepalis accrescentibus, persistentibus, usque ad 12 mm longis et 6 mm latis.

A dioecious shrub, 1 to 3 m high, the younger parts more or less pubescent, branches terete, glabrous, grayish. Leaves lanceolate, entire, chartaceous, 12 to 20 cm long, 2.5 to 4 cm wide, subequally narrowed to the usually cuneate base and to the rather slenderly acuminate apex, the acumen blunt, the upper surface dark olivaceous, slightly shining, glabrous, smooth, the lower surface usually brownish, sparingly pubescent along the midrib; lateral nerves 9 to 11 on each side of the midrib, prominent on the lower surface, distant, arched-anastomosing, the reticulations lax, often rather distinct; petioles somewhat pubescent, 5 to 15 mm long. Pistillate inflorescences axillary, slender, simple, up to 6 cm long, spicate or subracemose, pubescent, few-flowered, the bracts lanceolate, 8 to 14 mm long, 2.5 to 3 mm wide, slightly pubescent, sometimes more or less falcate. Sepals eglandular, lanceolate, acuminate, slightly pubescent, 6 mm long, 2.5 mm wide. Petals glabrous, dark purple, 5 to 6 mm long. Ovary glabrous; styles 3, cleft nearly to the base, the style-arms linear, acuminate, 1.5 mm long. Capsules depressed-globose, about 12 mm in diameter, brown, composed of 3 cocci, sparingly appressed-pubescent, the sepals accrescent in fruit and up to 12 mm long and 6 mm wide.

MINDANAO, Zamboanga District, Malangas, *Bur. Sci. 36764.*

(type) *36560 Ramos & Edaño,* October, 1919. On forested slopes at low altitudes, with the local name *pululi.*

A species well characterized by its narrow, lanceolate, rather slenderly acuminate leaves.

CYCLOSTEMON Blume

CYCLOSTEMON BAWANII sp. nov.

Arbor circiter 15 m alta, floribus et fructibus exceptis glabra; foliis oblongis, integris, coriaceis, nitidis, pallide olivaceis, 10 ad 14 cm longis, basi plus minusve decurrento-acuminatis, leviter inaequilateralibus, apice obtuse acuminatis, nervis utrinque circiter 8, tenuibus; floribus ♂ axillaribus, fasciculatis, pedicellatis, pedicellis 6 ad 8 mm longis; sepalis 4, obovatis, circiter 7 mm longis, exterioribus leviter, interioribus dense pubescentibus; staminibus circiter 15; fructibus ellipsoideis, brunneis, solitariis, leviter adpresse pubescentibus, 1.5 cm longis, obtusis, 2-locellatis, pericarpio fragile.

A tree about 15 m high, glabrous except the flowers and fruits, branches and branchlets pale brown or straw-colored when dry. Leaves oblong, entire, coriaceous, shining, pale olivaceous or somewhat brownish when dry, 10 to 14 cm long, 2.5 to 5 cm wide, narrowed below to the somewhat decurrent-acuminate and slightly inequilateral base, and above to the blunt-acuminate apex; lateral nerves about 8 on each side of the midrib, slender, slightly projecting on the lower surface, and somewhat curved, the reticulations rather distinct; petioles about 1 cm long. Staminate flowers axillary, fascicled, white, fragrant, their pedicels slightly pubescent, 6 to 8 mm long. Sepals 4, obovate, about 7 mm long, the two outer ones slightly pubescent, the two inner ones densely and uniformly pubescent with short, pale-brownish hairs. Stamens about 15, the filaments 2 to 2.5 mm long, glabrous. Anthers oblong-ovate, 2.2 mm long. Fruits solitary, ellipsoid, pale brown and slightly verrucose when dry, sparingly appressed-pubescent, about 1.5 cm long, 1 cm wide, obtuse, 2-celled, but often only one seed developing, the pericarp rather thin, brittle; pedicels about 5 mm long, slightly pubescent.

LUZON, Tayabas Province, Atimonan, *For. Bur. 25357 Bawan,* April 12, 1916, in fruit (type); Unisan, *For. Bur. 25034 Bawan,* February 15, 1916, with staminate flowers. In forests along streams and on slopes, altitudes 100 to 300 meters.

The alliance of this species seems to be with *Cyclostemon mindanaensis* Merr., from which it is distinguished by its smaller, differently shaped fruits.

CYCLOSTEMON OLIGOPHLEBIUM sp. nov.

Arbor glabra; foliis chartaceis, oblongo-ovatis ad ellipticis, 8 ad 12 cm longis, integris, in siccitate pallide olivaceis, basi acutis ad rotundatis, equilateralibus vel leviter inaequilateralibus, apice tenuiter acuminatis, nervis utrinque circiter 5, perspicuis; floribus ♀ axillaribus, solitariis, breviter (2 mm) pedicellatis, sepalis late ovatis, rotundatis, 5 ad 6 mm longis, leviter pubescentibus, ovario pubescente; fructibus globosis, glabris, circiter 2.5 cm diametro, 2-locellatis, pericarpio fragile, seminibus 2, plano-convexis, ellipticis, 1.3 cm longis.

A glabrous tree, 8 to 12 m high, the branches and branchlets grayish, slender. Leaves chartaceous, oblong-ovate to elliptic, 8 to 12 cm long, 3.5 to 6 cm wide, pale olivaceous and slightly shining when dry, entire, the base acute to rounded, equilateral or slightly inequilateral, the apex rather slenderly acuminate; lateral nerves about 5 on each side of the midrib, slender, curved, anastomosing, distinct on the lower surface as are the lax reticulations; petioles 5 to 8 mm long. Pistillate flowers solitary, axillary, their pedicels about 2 mm long, glabrous. Sepals 4, broadly ovate, rounded, 5 to 6 mm long, slightly pubescent. Ovary globose, pubescent, 4 mm in diameter, the stigma broadly 2-lobed, the lobes reniform, about 2 mm wide. Fruits globose, glabrous, about 2.5 cm in diameter, 2-celled, 2-seeded, brown when dry, brittle. Seeds plano-convex, elliptic, about 1.3 cm long.

MINDORO, Bongabong River, *For. Bur. 4036 Merritt*, March 28, 1906 (type), *For. Bur. 12210 Rosenbluth,* May 21, 1908. In forests at low altitudes, with the local name *bato-bato.*

A species probably as closely allied to *Cyclostemon microphyllus* Merr. as any other described form, apparently well characterized by its few-nerved leaves.

HOMALANTHUS Jussieu

HOMALANTHUS CONCOLOR sp. nov. § *Monosepali.*

Frutex glaber; foliis orbiculari-ovatis, obscure obtuseque acuminatis, basi late rotundatis, peltatis, subtus perspicue biglandulosis, olivaceis, nitidis, utrinque concoloribus, 5 ad 7 cm longis; floribus ♂ numerosis, bracteis biglandulosis, unifloris, staminibus circiter 30; fructibus circiter 5 mm diametro.

An entirely glabrous monoecious shrub, the branches and branchlets brownish olivaceous, smooth. Leaves peltate, orbicular-ovate, chartaceous, 5 to 7 cm long, shining, olivaceous and of the same color on both surfaces, apex broadly rounded,

the petioles 3 to 6 cm long, inserted 0.3 to 1 cm from the margin and with two conspicuous glands at the juncture with the lamina; lateral nerves 6 to 8 on each side of the midrib, conspicuous. Inflorescences up to 10 cm long. Staminate flowers numerous, about 1.5 mm in diameter, their pedicels up to 3 mm long, the bracts small, entire, 1-flowered, each with two conspicuous contiguous glands; sepal 1, orbicular-reniform, about 1 mm in diameter; stamens about 30, the anthers subsessile, minutely papillate. Fruits 8 to 10 at the base of the inflorescence, subglobose, about 5 mm in diameter, their pedicels about 4 mm long; styles very early deciduous, not seen.

MINDANAO, Bukidnon Subprovince, near Tankulan, *Bur. Sci. 39166 Ramos & Edaño,* July, 1920, with the local name *labagti.* Habitat not recorded, altitude indicated as about 1,000 meters.

ALCHORNEA Swartz

ALCHORNEA PUBESCENS sp. nov. § *Cladodes.*

Species A. rugosae affinis, differt ramulis et infructescentiis et subtus foliis molliter subferrugineo-villosis, foliis caudato-acuminatis, nervis magis numerosis, utrinque circiter 15.

A shrub about 3 m high, the branchlets, inflorescences, and lower surface of the leaves softly subferruginous-villous, the indumentum often dense. Leaves oblanceolate, 17 to 25 cm long, 3 to 6 cm wide, slenderly caudate-acuminate, the acumen often falcate, narrowed below to the abruptly auriculate-cordate base, the margins distantly glandular-toothed, the upper surface glabrous except for the slightly hirsute midrib, olivaceous, the base with 1 or 2 conspicuous glands and usually with 1 or 2 similar glands between each pair of nerves in the lower one-half to two-thirds; lateral nerves about 15 on each side of the midrib, prominent, curved, arched-anastomosing, the primary reticulations also prominent; petioles densely pubescent, about 5 mm long; stipules linear, pubescent, 7 to 10 mm long. Pistillate inflorescences terminal or subterminal, more or less pubescent, spiciform, 7 to 10 cm long, each flower subtended by a pair of conspicuous glands. Fruits depressed-globose, about 9 mm wide, pubescent, the style arms 3, slightly pubescent, about 5 mm long.

LUZON, Cagayan Province, Peñablanca, *For. Bur. 22724 Castillo,* April 23, 1915. On slopes at low altitudes.

A species very similar and manifestly closely allied to *Alchornea rugosa* Muell.-Arg., from which it differs in its softly

villous branchlets and lower surface of the leaves and in its slenderly caudate-acuminate leaves which are more numerously nerved than in the latter species.

CLEISTANTHUS Hooker f.

CLEISTANTHUS BARROSII sp. nov. § *Ferruginosi.*

Arbor circiter 8 m alta, ramulis et petiolis et subtus foliis ad costa nervisque ferrugineo-pubescentibus; foliis chartaceis, olivaceis, nitidis, oblongo-ovatis ad oblongo-ellipticis, 14 ad 20 cm longis, 5 ad 8 cm latis, acuminatis, basi acutis, nervis utrinque circiter 8, perspicuis; fasciculis ferrugineo-pubescentibus, calycis tubo 1.4 mm longo, lobis oblongo-lanceolatis, acuminatis, tubo aequantibus, petalis obovatis, circiter 1 mm longis; fructibus obovoideis, 8 ad 10 mm longis, retusis, junioribus parce ferrugineo-villosis, vetustioribus glabris vel subglabris.

A tree about 8 m high, the branchlets, petioles, and midribs and nerves on the lower surface of the leaves rather densely ferruginous-pubescent. Branches terete, smooth, glabrous, 3 to 4 mm in diameter, grayish or brownish when dry. Leaves oblong-ovate to oblong-elliptic, 14 to 20 cm long, 5 to 8 cm wide, chartaceous, olivaceous, somewhat shining, distinctly acuminate, base acute, the upper surface entirely glabrous; lateral nerves about 8 on each side of the midrib, prominent, ascending, the reticulations distinct; petioles about 1 cm long. Fascicles axillary, densely ferruginous-pubescent, the bracts broadly ovate, slightly acuminate, about 3 mm long. Pistillate calyx appressed-pubescent, the tube about 1.4 mm long, the lobes oblong-lanceolate, somewhat acuminate, about as long as the tube. Petals obovate, 1 mm long or less. Fruits reddish-yellow when fresh, dark-brown when dry, distinctly stipitate, ellipsoid or obovoid, retuse, 8 to 10 mm long, the younger ones sparingly ferruginous-villous, in age glabrous or nearly so.

LUZON, Isabela Province, Ilagan, *For. Bur. 26070 Barros,* June 23, 1916. In primary forests on slopes at an altitude of about 200 meters.

A species belonging in the section *Ferruginosi* and apparently most closely allied to *Cleistanthus rufescens* Jabl.

CLEIDION Blume

CLEIDION RAMOSII (Merr.) comb. nov.

Mallotus ramosii Merr. in Philip. Journ. Sci. 7 (1912) Bot. 401; Pax & Hoffm. in Engl. Pflanzenreich 63 (1914) 195.

Mallotus samarensis Merr. op. cit. 9 (1914) 488; Pax & Hoffm. op. cit. 68 (1919) 18.

MINDORO, Mount Calavite, *Bur. Sci. 39395, 39408 Ramos.* SAMAR, *Bur. Sci. 17480 Ramos.* CAMIGUIN DE MISAMIS, *Bur. Sci. 14602 Ramos.* SIARGAO, *Bur. Sci. 35031, 34829 Ramos.* In forests at low and medium altitudes, ascending to 1,000 meters.

Additional material shows that the two species described by me can scarcely be maintained as distinct, and further that the species belongs in *Cleidion* rather than in *Mallotus*, although the connectives are scarcely produced. The leaves are eglandular, the staminate inflorescences are simply spicate, while the capsules are glabrous, unarmed, and eglandular. The plant is monoecious, the pistillate inflorescences being racemose, few-flowered (sometimes only 1-flowered) and 4 to 12 cm long. The capsules are composed of 3, dehiscent, glabrous cocci, and are about 8 mm in diameter. Seeds mottled.

ANACARDIACEAE

MANGIFERA Linnaeus

MANGIFERA PARVIFOLIA sp. nov.

Arbor, inflorescentiis exceptis glabra; foliis subcoriaceis, oblongo-ovatis, 5 ad 10 cm longis, utrinque subaequaliter angustatis, acuminatis, basi acutis, nervis utrinque circiter 10, distinctis, paniculis pubescentibus, 4 ad 9 cm longis; floribus 4-meris, sepalis glabris, 2.5 mm longis, petalis subellipticis, obtusis, 3.5 mm longis, deorsum perspicue 3-costatis, costae confluentibus, sursum tenuibus, evanescentibus; staminibus fertilibus 1, staminoideis 3, minutis; fructibus junioribus ellipsoideis, 2 cm longis, seminibus laevis. Species M. monandrae Merr. affinis.

A tree up to 20 m high, glabrous except the inflorescences. Leaves subcoriaceous, oblong-ovate, rather pale when dry, 5 to 10 cm long, 2 to 3 cm wide, subequally narrowed to the acute or somewhat decurrent base and to the distinctly acuminate apex; lateral nerves about 10 on each side of the midrib, slender, distinct, projecting on both surfaces, the reticulations rather distinct; petioles 1.5 to 2.5 cm long. Panicles terminal, pubescent, 4 to 9 cm long. Flowers white, 4-merous. Sepals oblong-ovate to oblong-lanceolate, obtuse, glabrous, about 2.5 mm long. Petals elliptic to oblong-elliptic, obtuse, 3.5 mm long, prominently 3-costate in the lower half, the costae confluent below, attenuate in the upper half and not reaching the margins and with two lateral, slender nerves which are not thickened into distinct ridges in the lower part. Disk thick, 4-lobed, wider than the

ovary. Ovary ovoid, inequilateral, glabrous. Fertile stamen 1, the filament 3 mm long; staminodes 3, very slender, 0.5 mm long or less. Immature fruits ellipsoid, 2 cm long, glabrous, the seed compressed and apparently smooth.

LUZON, Zambales Province, Masinloc, *Merrill 2946*, May, 1903, *For. Bur. 27169 Maneja & Bawan* (type), May, 1918. To this species I also refer *For. Bur. 25497 Cruz* from Lanao District, Mindanao, although this specimen differs from the type in its very slenderly acuminate leaves.

Among the Philippine species the present one is most closely allied to *Mangifera monandra* Merr., from which it is distinguished by its much smaller leaves, smaller flowers, and pubescent inflorescences. It belongs in the group with *M. quadrifida* Jack.

CELASTRACEAE

LOPHOPETALUM Wight

LOPHOPETALUM PAUCINERVIUM sp. nov.

Arbor glabra, circiter 10 m alta; foliis coriaceis, oblongo-ellipticis, 10 ad 16 cm longis, integris, breviter obtuse acuminatis, basi rotundatis ad late acutis, in siccitate brunneo-olivaceis, subtus pallidioribus, nervis utrinque 5 vel 6, curvato-adscendentibus, perspicuis; paniculis axillaribus terminalibusque, 12 ad 15 cm longis; floribus circiter 7 mm diametro, calycis 5-angulatis, lobis brevissimis, acutis, petalis ovatis, obtusis, 3 mm longis, longitudinaliter cristatis, junioribus apice leviter fimbriatis, vetustioribus integris.

An entirely glabrous tree about 10 m high, the branches and branchlets purplish-black when dry, somewhat rugose. Leaves coriaceous, oblong-elliptic, entire or the margins obscurely undulate, 10 to 16 cm long, 5 to 8 cm wide, the apex with a broad, short, obtuse acumen, the base rounded to broadly acute, the upper surface when dry brownish-olivaceous, the lower paler; lateral nerves 5 or 6 on each side of the midrib, curved-ascending, obscurely anastomosing, prominent on the lower surface, the reticulations slender; petioles 1 to 2 cm long. Panicles axillary and terminal, 12 to 15 cm long. Flowers white, about 7 mm in diameter, their pedicels up to 4 mm long, the bracteoles lanceolate, acuminate, about 0.6 mm long. Calyx about 4 mm in diameter, 5-angled, the lobes short, acute. Petals ovate, obtuse, 3 mm long, the younger ones slightly fimbriate at their apices, the older ones entire, longitudinally cristate on the inner face.

Filaments 2 mm long; anthers 1.2 mm in length. Disk 5-angled, filling the shallow calyx tube, about 4 mm in diameter.

MINDANAO, Bukidnon Subprovince, near Tankulan, *Bur. Sci. 39136 Ramos & Edaño,* July, 1920. In damp forests at an altitude of about 900 meters.

The second species of the genus to be found in the Philippines, readily distinguishable from *Lophopetalum toxicum* Loher by its few-nerved leaves.

SABIACEAE

MELIOSMA Blume

MELIOSMA BONTOCENSIS sp. nov.

Frutex vel arbor parva, inflorescentiis exceptis glabra; foliis simplicibus, subellipticis, coriaceis, nitidis, integris, 5 ad 10 cm longis, obtusis ad rotundatis vel brevissime subapiculato-acuminatis, basi acutis, nervis utrinque circiter 8, supra impressis, subtus valde perspicuis, petiolo 1.2 ad 2 cm longo; paniculis 10 ad 12 cm longis, multifloris, partibus junioribus perspicue ferrugineo-pubescentibus; floribus confertis, petalis glabris, exterioribus orbicularis, 2.5 mm diametro, sepalis bracteolisque minoribus, margine leviter ciliatis. Species M. vulcanicae Merr. affinis.

A shrub or small tree, glabrous except the inflorescences, the ultimate branches about 4 mm in diameter. Leaves simple, subelliptic, coriaceous, 5 to 10 cm long, 3.5 to 5 cm wide, brownish-olivaceous and more or less shining when dry, the lower surface paler than the upper, the midrib and nerves very dark brown in contrast to the paler surface, the apex obtuse to rounded or very shortly subapiculate, the base acute, the margins entire; lateral nerves about 8 on each side of the midrib, more or less impressed on the upper surface, very prominent on the lower surface, anastomosing, the reticulations distinct; petioles 1.2 to 2 cm long. Panicles 10 to 12 cm long, the younger parts ferruginous-pubescent, the older parts glabrous or nearly so, the primary branches 3 to 6 cm long. Flowers yellow when fresh, crowded, sessile. Sepals 5, brown, orbicular to orbicular-ovate, rounded, 1.8 mm in diameter, the margins somewhat ciliate, the calyx subtended by 2 or 3 bracteoles similar to the sepals but smaller in size. Outer three petals imbricate, glabrous, orbicular to obovate, concave, about 2.5 mm in diameter, the inner two oblong-obovate to spatulate, thin, entire, free, about 1.8 mm long. Filaments of the fertile stamens 1 mm long. Sterile stamens

suborbicular, bifid, 1 to 1.2 mm in diameter. Ovary oblong-ovoid, glabrous, about 1 mm long. Disk thin, truncate, 0.5 mm **high.**

LUZON, Bontoc Subprovince, Mount Pukis, *Bur. Sci. 37756 Ramos & Edaño,* March 11, 1920. In the mossy forest, altitude about 1,900 meters.

A species closely allied to *Meliosma vulcanica* Merr. but with thicker leaves which are rounded to obtuse or merely apiculate, not acuminate at the apex, shorter petioles, and more conspicuous lateral nerves which are usually more or less impressed on the upper surface.

SAPINDACEAE

GUIOA Cavanilles

GUIOA MINDORENSIS sp. nov.

Frutex subglaber, ramulis junioribus leviter adpresse pubescentibus; foliis circiter 12 cm longis, rhachibus glabris, sursum anguste alatis vel carinatis, foliolis plerumque 7, oblongo-ellipticis ad oblongo-lanceolatis, subcoriaceis, 5 ad 7 cm longis, subtus parcissime pubescentibus, apice obtuse acuminatis, basi decurrento-acuminatis, plerumque inaequilateralibus, nervis utrinque circiter 6, subtus cum reticulis perspicuis; infructescentiis axillaribus, paniculatis, circiter 6 cm longis; sepalis ovatis, 2 mm longis, margine ciliatis; fructibus late obovatis, retusis, glabris, 1 cm longis latisque.

A nearly glabrous shrub about 4 m high, the branches terete, dark-colored when dry, the very young branchlets obscurely appressed-pubescent. Leaves about 12 cm long, the petiole and rachis glabrous, the rachis in the upper part very narrowly winged or carinate; leaflets usually 7, oblong-elliptic to oblong-lanceolate, subcoriaceous, 5 to 7 cm long, 1.3 to 2 cm wide, the upper surface olivaceous, smooth, glabrous or slightly pubescent along the midrib, the lower surface paler, glabrous or with very few, widely scattered, short hairs, narrowed above to the obtusely acuminate apex and below to the usually inequilateral and decurrent-acuminate base; lateral nerves about 6 on each side of the midrib, prominent on the lower surface, arched-anastomosing, the primary reticulations distinct. Infructescences axillary, paniculate, about 6 cm long, slightly pubescent. Sepals broadly ovate, rounded, 2 mm long, their margins somewhat ciliate. Fruits broadly obovate, equally 3-winged, the apex retuse and apiculate, about 1 cm long and usually slightly wider than long, glabrous, smooth, shining.

MINDORO, Paluan, *Bur. Sci. 39639 Ramos,* April 13, 1921. On forested slopes, altitude about 550 meters.

In aspect this species rather closely resembles a small-leafed form of *Guioa koelreuteria* (Blanco) Merr. (*G. perrottetii* Radlk.). Its distinguishing characters are its small leaflets and the narrowly winged or carinate upper portions of the leaf rachises. In the latter character it somewhat approaches *Guioa pleuropteris* Radlk., but is remote from that species in all other characters.

RHAMNACEAE

RHAMNUS Tournefort

RHAMNUS MOLLIS sp. nov.

Frutex scandens, molliter pubescens; foliis subcoriaceis, ellipticis, 10 ad 13 cm longis, breviter acuminatis, basi rotundatis, margine minute crenato-dentatis, nervis utrinque 6, perspicuis; infructescentiis paniculatis, circiter 12 cm longis, ramis racemose dispositis, 5 ad 10 cm longis; fructibus pedicellatis, obovoideis, glabris, circiter 8 mm longis, calycis persistentibus, truncatis, disciformibus, pubescentibus, 2 mm diametro.

A scandent shrub, the younger parts, leaves, and inflorescences softly subferruginous-pubescent, branches terete, about 3 mm in diameter. Leaves subcoriaceous, elliptic, 10 to 13 cm long, 6 to 7.5 cm wide, olivaceous, shortly acuminate, base usually rounded, the margins rather minutely crenate-dentate, the lower surface densely and softly pubescent with short hairs; lateral nerves 6 on each side of the midrib, prominent; petioles more or less pubescent, about 1.5 cm long. Fruits racemosely arranged on leafless branches forming a paniculate infructescence about 12 cm long, this infructescence sometimes supplied with a few very greatly reduced leaves, the branches 5 to 10 cm long. Fruits solitary or in pairs, obovoid, glabrous, brown when dry, about 8 mm long, the persistent calyx disklike, truncate, pubescent, about 2 mm in diameter.

LUZON, Bontoc Subprovince, Mount Polis, *Bur. Sci. 37689 Ramos & Edaño,* February 25, 1920. In the mossy forest, altitude about 1,600 meters.

Among the Philippine species the present one is manifestly allied to *Rhamnus philippinensis* C. B. Rob., from which it is at once distinguishable by its indumentum; among the extra-Philippine species it is apparently closest to *R. triqueter* Wall. of India.

VITACEAE

LEEA Royen

LEEA NITIDA sp. nov.

Arbor glabra, 5 ad 6 m alta, ramis lenticellatis; foliis pinnatis, circiter 30 cm longis, foliolis 5 ad 7, oblongo-ovatis ad late oblongo-lanceolatis, chartaceis, nitidis, in siccitate brunneo-olivaceis, 12 ad 18 cm longis, 4 ad 6 cm latis, caudato-acuminatis, basi acutis, margine repando-dentatis vel undulato-denticulatis, eglandulosis, nervis utrinque circiter 8, distinctis; cymis 5 ad 6 cm longis, pedunculatis, paucifloris; floribus albidis, 4-meris, breviter pedicellatis, calycis cupulatis, 4 ad 5 mm longis, basi cuneatis, lobis late ovatis, obtusis vel subacutis, usque ad 1.5 mm longis, corolla 6 mm longa, lobis patulis, 3 mm longis, intus ad apicem appendiculatis; fructibus obovoideis, 1 ad 1.5 cm diametro, seminibus plerumque 4.

A glabrous tree 5 to 6 m high, the branches lenticellate, the ultimate branchlets rugose, 2.5 to 3 mm in diameter. Leaves pinnate, about 30 cm long, the leaflets 5 to 7, oblong-ovate to broadly oblong-lanceolate, chartaceous, shining, when dry brownish-olivaceous, eglandular, 12 to 18 cm long, 4 to 6 cm wide, rather slenderly caudate-acuminate, the base acute, the margins repand-dentate or undulate-denticulate; lateral nerves about 8 on each side of the midrib, distinct, as are the reticulations; petiolules 8 to 12 mm long. Cymes including the peduncles 5 to 6 cm long, about as wide as long, few-flowered, the flowers white, 4-merous, shortly pedicelled; calyx cup-shaped, 4 to 5 mm long, the base cuneate, the lobes broadly ovate, obtuse to subacute, about 1.5 mm long. Corolla 6 mm long, the lobes spreading, 3 mm long, appendiculate at the apex inside, the staminal tube exserted, about 2 mm, 8-toothed; anthers 2 mm long. Fruits obovoid, 1 to 1.5 cm in diameter, reddish. Seeds usually 4.

LUZON, Apayao Subprovince, Mount Sulu, *Bur. Sci. 28428 Fénix* (type), May, 1917: Laguna Province, San Antonio, *Bur. Sci. 20406 Ramos,* February, 1913: Tayabas Province, Mount Binuang, *Bur. Sci. 28830 Ramos & Edaño,* May, 1917. In damp forests along small streams at low and medium altitudes.

A species apparently belonging in the group with *Leea philippinensis* Merr., well characterized by its small, few-flowered, rather lax cymes and its chartaceous, shining leaflets.

DILLENIACEAE

SAURAUIA Willdenow

SAURAUIA LONGIPEDICELLATA sp. nov.

Frutex glaber; foliis oblanceolatis, chartaceis ad subcoriaceis, 11 ad 20 cm longis, breviter acuminatis, deorsum sensim angustatis, basi cuneatis, margine minute dentatis, nervis utrinque circiter 14, perspicuis; floribus paucis, longe pedicellatis, 1.8 cm diametro, fasciculatis, caulinis et axillaribus, pedicellis usque ad 5 cm longis, sepalis exterioribus 3 ad 3.5 mm longis, interioribus majoribus; staminibus 20; stylis 3, circiter 4 mm longis, deorsum breviter connatis.

An entirely glabrous shrub, the ultimate branches brownish, smooth, about 5 mm in diameter. Leaves oblanceolate, chartaceous to subcoriaceous, 11 to 20 cm long, 4 to 5.5 cm wide, brown when dry, slightly shining, the apex rather abruptly and shortly acuminate, gradually narrowed below to the cuneate base, the margin except in the lower one-third to one-half rather finely dentate; lateral nerves about 14 on each side of the midrib, abruptly curved and then ascending. Flowers white, fascicled on the trunk and larger branches and also in the leaf axils, about 1.8 cm in diameter, their pedicels slender, up to 5 cm long, usually with a pair of small, lanceolate bracts at or near the middle from 1 to 3 mm in length. Outer 2 sepals elliptic-ovate, 3 to 3.5 mm long, the inner 3 thinner, orbicular-elliptic, 5 mm long, broadly rounded, all entirely glabrous. Corolla lobes 7 to 8 mm long, 5 mm wide, retuse. Stamens 20, their filaments 2 mm long, the anthers equaling the filaments. Styles 3, about 4 mm long, united for the lower 1 mm. Fruits ovoid, about 6 mm in diameter.

MINDANAO, Zamboanga District, Malangas, *Bur. Sci. 36897 Ramos & Edaño*, November, 1919. In forests along streams at low altitudes.

A species strongly characterized by being entirely glabrous throughout, as well as by its unusually long, slender pedicels. It apparently belongs in the general group with *S. trunciflora* Merr.

THEACEAE

PYRENARIA Blume

PYRENARIA MINDANAENSIS sp. nov.

Frutex circiter 3 m altus, partibus junioribus parce pubescentibus, ramis teretibus, glabris; foliis chartaceis vel sub-

coriaceis, oblongo-obovatis, subolivaceis vel viridis, nitidis, utrinque glabris, 8 ad 15 cm longis, acuminatis, basi cuneatis, margine crenato-serratis, dentibus glanduloso-apiculatis, nervis utrinque circiter 12, subtus valde perspicuis, arcuato-anastomosantibus, reticulis laxis, perspicuis; floribus axillaribus, solitariis, sessilibus, circiter 3 cm diametro; sepalis suborbicularis cum bracteolis persistentibus, 6 ad 7 mm longis; petalis 5, obovatis, circiter 1.8 cm longis, extus adpresse pubescentibus; filamentis numerosis, 8 ad 10 mm longis, glabris, deorsum (2 mm) connatis; fructibus ovoideis, 1.5 ad 2 cm longis, 2- vel 3-locellatis.

A shrub about 3 m high, the younger parts more or less appressed-pubescent, the older parts glabrous, branches terete, grayish or brownish, the young branchlets greenish when dry. Leaves chartaceous to subcoriaceous, oblong-obovate, subolivaceous or greenish when dry, somewhat shining, glabrous on both surfaces or when young very slightly hirsute on the lower surface, 8 to 15 cm long, 2.5 to 5.5 cm wide, obtusely acuminate, the base cuneate, the margins crenate-serrate, the teeth glandular, apiculate; lateral nerves about 12 on each side of the midrib, very prominent on the lower surface as are the lax reticulations; petioles 5 to 8 mm long. Flowers axillary, solitary, sessile, about 3 cm in diameter. Sepals subcoriaceous, persistent, broadly ovate to reniform-ovate or orbicular, rounded, 6 to 7 mm long, externally densely appressed-pubescent, the subtending bracts numerous, imbricate, similar to the sepals but smaller. Petals 5, obovate, about 18 mm long, rounded, externally appressed-pubescent. Stamens indefinite, the filaments 8 to 10 mm long, glabrous, united for the lower 2 mm, the anthers broadly ovoid, about 1.2 mm long. Ovary ovoid, pubescent, 2 to 2.5 mm long; styles 5 to 6 mm long, glabrous, the 5 arms about 2 mm in length. Fruits ovoid, brown, ultimately glabrous, 1.5 to 2 cm long, usually 2- or 3-celled and with a single seed in each cell, the seeds smooth, slightly compressed, narrowed at both ends, about 1.5 cm long.

MINDANAO, Lanao District, *For. Bur. 25181 Alvarez* (type), March, 1916; Bukidnon Subprovince, Mount Candoon, *Bur. Sci. 38839 Ramos & Edaño,* July, 1920. In damp forests at an altitude of 1,200 meters. Originally determined as a *Thea.*

This is the first representative of the genus to be found in the Philippines. In vegetative characters it rather closely resembles *Pyrenaria camelliaeflora* Kurz, but is very different in its floral characters.

GUTTIFERAE

CALOPHYLLUM Linnaeus

CALOPHYLLUM OBLIQUINERVIUM sp. nov. § *Inophyllum.*

Arbor glaberrima, 7 ad 12 m alta, ramulis plus minusve 4-angulatis; foliis coriaceis, oblongo-obovatis ad oblanceolatis, nitidis, 5 ad 9 cm longis, obtusis ad breviter obtuse acuminatis, basi cuneatis; nervis utrinque numerosis, obliquis, obscuris; inflorescentiis racemosis, foliis subaequantibus; floribus circiter 1.5 cm diametro, sepalis exterioribus orbiculari-obovatis, concavis, 3.5 ad 5 mm diametro, interioribus majoribus, ovatis ad obovatis; petalis 4, 7 ad 9 mm longis, oblanceolatis ad anguste obovatis; fructibus globosis, apiculatis, circiter 1.5 cm diametro.

An entirely glabrous tree 7 to 12 m high, the branches terete, dark reddish-brown, the younger branchlets more or less 4-angled. Leaves coriaceous, oblong-obovate to oblanceolate, shining, olivaceus or brownish olivaceous when dry, 5 to 9 cm long, 1.5 to 3.5 cm wide, narrowed upward to the obtuse or very shortly and obtusely acuminate apex and below to the cuneate base; lateral nerves very numerous, crowded, slender, sometimes scarcely distinguishable, ascending at an angle of about 45°; petioles 1 to 1.5 cm long. Inflorescences racemose, axillary, usually solitary, about as long as the leaves, the buds globose, the flowers white, fragrant, about 1.5 cm in diameter, their pedicels 5 to 12 mm in length. Outer 2 sepals orbicular-ovate, concave, rounded, 3.5 to 5 mm in diameter, the inner 2 ovate to obovate, rounded, 7 to 8 mm long. Petals 4, oblanceolate to narrowly obovate, obtuse, 7 to 9 mm long, 2 to 5 mm wide. Stamens very numerous, their filaments 2.5 to 3.5 mm long. Ovary glabrous; style 4 to 5 mm long. Fruits globose, very shortly apiculate, about 1.5 cm in diameter.

LUZON, Camarines Province, *For. Bur. 21423 Alvarez,* May, 1914, in fruit, *For. Bur. 27096 Alambra,* March, 1918, with young fruits: Albay Province, Rapurapu, *For. Bur. 20108 Agnes,* sterile. PANAY, *For. Bur. 15130 Cenabre,* sterile. SAMAR, *Merrill Phil. Pl. 1630,* April, 1914, with immature fruits. PALAWAN, *For. Bur. 27929 Cenabre, Paras, & Gallidon* (type), February, 1920, *For. Bur. 27902 Cenabre, Baldimor, & Eduviso,* February, 1920, *Merrill 9585,* May, 1913. On forested slopes at low and medium altitudes, sometimes occurring on the seashore and immediately back of the mangrove swamps. Local names, *bitanghol* (Tag.), *kumukubol* (Tagb.), *bangkalan* (Tag.).

A species well characterized by its simple, racemose inflorescences and its obliquely nerved leaves, the very slender and often obscure lateral nerves ascending at an angle of about 45° and giving the leaf surface a striated appearance; the individual nerves are scarcely distinguishable under a lens. The alliance of this species appears to be with *Calophyllum buxifolium* Vesque, but it has much larger leaves than the latter species.

FLACOURTIACEAE

CASEARIA Jacquin

CASEARIA MINDANAENSIS sp. nov.

Frutex vel arbor parva, subglabra; foliis magnis, oblongis ad oblongo-ellipticis, circiter 30 cm longis, subcoriaceis, acuminatis, basi subacutis ad obtusis, margine minute denticulatis vel deorsum integris, subtus ad costa nervisque leviter puberulis, vetustioribus glabris, nervis utrinque circiter 9, adscendentibus, subtus valde perspicuis, reticulis subconfertis, distinctis, petiolo incrassato, 8 ad 10 mm longo; floribus fasciculatis, ut videtur paucis, brevissime pedicellatis, sepalis 4 mm longis, obtusis, punctato-glandulosis, glabris; capsulis 1.5 ad 1.8 cm longis, 2-valvis, haud costatis, subellipsoideis, acutis vel brevissime apiculatis; seminibus 4 ad 4.5 mm longis, obtusis, inaequilateralibus, arillo grosse fimbriato.

A shrub or small tree, the younger parts sparingly pubescent, ultimately glabrous, branches terete, grayish, about 5 mm in diameter, glabrous, distinctly lenticellate, the very young branchlets more or less pubescent. Leaves oblong to oblong-elliptic, about 30 cm long, 11 to 12 cm wide, the upper surface olivaceous, glabrous, the lower surface somewhat brownish and when young obscurely pubescent on the midrib and nerves, ultimately glabrous, the apex acuminate, the base subacute to obtuse, the margins minutely denticulate or entire in the lower part; lateral nerves about 9 on each side of the midrib, ascending, very prominent on the lower surface, the reticulations distinct, rather close; petioles thickened, 8 to 10 mm long. Flowers fascicled, apparently few, very shortly pediceled, persistent sepals 4 mm long, obtuse, glandular-punctate, glabrous or nearly so. Capsules glabrous, reddish yellow when fresh, dark brown when dry, subellipsoid, acute or very shortly apiculate, not costate, 1.5 to 1.8 cm long, 2-valved; seeds 4 to 4.5 mm long, inequilateral, somewhat compressed, obtuse, the aril exceeding the seed in length and coarsely fimbriate.

MINDANAO, Zamboanga District, Mount Tubuan, *Bur. Sci. 36567 Ramos & Edaño,* October, 1919. In forests along streams at an altitude of about 200 meters; locally known as *dalipa.*

A species well characterized among the Philippine forms by its unusually large leaves.

THYMELAEACEAE

AQUILARIA Lamarck

AQUILARIA APICULATA sp. nov.

Frutex subglaber, ramis teretibus, glabris, ramulis leviter pubescentibus; foliis chartaceis vel subcoriaceis, breviter petiolatis, oblongis, in siccitate brunneis, nitidis, 6 ad 11 cm longis, tenuiter acute acuminatis, basi acutis, subtus leviter pubescentibus, nervis primariis utrinque circiter 16, tenuibus; inflorescentibus subumbellatis vel cymosis, paucifloris, breviter pedunculatis; floribus 5-meris, sursum ampliatis, vix campanulatis, 5 mm longis, tenuiter pedicellatis, lobis orbicularibus, 2 mm longis; capsulis subellipsoideis, pedunculatis, circiter 1.7 cm longis; 2-locellatis, perspicue apiculato-acuminatis, basi acutis.

A subglabrous shrub about 3 m high, the branches brown or reddish brown, glabrous, the branchlets more or less appressed-pubescent, slender. Leaves chartaceous to subcoriaceous, oblong, brownish when dry, shining, 6 to 11 cm long, 2.5 to 4 cm wide, the apex slenderly and sharply acuminate, the base acute, the upper surface glabrous, the lower paler, sparingly pubescent, lateral nerves about 16 on each side of the midrib, slender, distinct; petioles about 3 mm long. Flowers subumbellate or somewhat cymose, yellow, the peduncles up to 3 mm long, somewhat pubescent, the flowers few, mostly 3 to 5 on each peduncle, their pedicels slender, up to 7 mm long. Perianth about 5 mm long, somewhat widened upward and about 2.5 mm in diameter at the throat but scarcely campanulate, glabrous, the lobes 5, spreading or reflexed, very slightly pubescent, orbicular-ovate, rounded, 2 mm long. Anthers 10, 0.8 to 1 mm long, inserted immediately below and alternate with the orbicular, pubescent, 0.8 mm long scales, which are inserted at the apex of the perianth tube. Ovary obovoid, 2-celled, compressed, pubescent, shortly stipitate. Stigma about 1 mm in diameter. Capsules subellipsoid, red when fresh, dark brown when dry, distinctly peduncled, the peduncle at least as long as the persistent perianth tube, 2-celled, 2-valved, about 1.7 cm long, the base acute, the apex distinctly apiculate-acuminate. Seeds dark brown, smooth,

shining, about 8 mm long excluding the basal appendage which is conical in shape and about 3.5 mm long.

MINDANAO, Bukidnon Subprovince, Mount Camates, *Bur. Sci. 38601 Ramos & Edaño,* July 14, 1920. In dry forests, altitude about 1,100 meters.

This species is probably most closely allied to *Aquilaria malaccensis* Lam. from which it is readily distinguished by its apiculate and retuse capsules and by characters of its inflorescences and flowers.

MYRTACEAE

EUGENIA Linnaeus

EUGENIA MIRABILIS sp. nov. § *Jambosa.*

Arbor parva, glabra, ramulis valde incrassatis, usque ad 2 cm diametro; foliis verticillatis, sessilibus, oblanceolatis, coriaceis, usque ad 70 cm longis, deorsum valde angustatis, basi obtusis, nervis utrinque circiter 30, valde perspicuis; floribus caulinis, fasciculatis, sessilibus, 4-meris, calycis infundibuliformibus, circiter 1 cm longis, lobis orbiculari-reniformibus, circiter 8 mm diametro; filamentis usque ad 3.5 cm longis.

A glabrous shrub or small tree about 4 m high, the ultimate branches thick, somewhat angled, up to 2 cm in diameter. Leaves sessile, verticillate, in whorls of 4 or 5, oblong-oblanceolate, coriaceous, 60 to 70 cm long, 10 to 12 cm wide, smooth, brownish or olivaceous on the upper surface when dry, the lower surface pale, apex acute or acuminate, gradually narrowed to the abruptly obtuse base, the basal portion of the leaves 2.5 to 3 cm wide, the midrib very prominent on the lower surface and usually about 5 mm in diameter; lateral nerves about 30 on each side of the midrib, rather distant, very prominent, anastomosing 5 to 10 mm from the margin with the equally prominent, somewhat arched marginal nerves, the reticulations rather lax, not prominent. Flowers white, sessile, in fascicles or 5 or 6 on small tubercles along the trunks, the buds oblong-ovoid. Calyx about 1 cm long, funnel-shaped, the throat about 1 cm in diameter, lobes orbicular-reniform, about 8 mm in diameter; filaments slender, up to 3.5 cm long.

MINDANAO, Zamboanga District, Malangas, *Bur. Sci. 36772* (type), *37238, 37347 Ramos & Edaño,* October, 1919. In forests at low altitudes, locally known as *culodlab* and as *gulodlab.*

A remarkable species, at once distinguished by its greatly elongated, oblanceolate, sessile, verticillate leaves and by its ses-

sile, fascicled flowers which are borne on small tubercles on the trunks.

EUGENIA LANCILIMBA sp. nov. § *Jambosa.*

Frutex erectus glaber, ramis ramulisque teretibus, ramulis sulcatis; foliis oppositis, lanceolatis, subcoriaceis, 14 ad 20 cm longis, 2 ad 3.5 cm latis, utrinque subaequaliter angustatis, basi cuneatis, apice acuminatis, subtus perspicue glanduloso-punctatis, nervis utrinque circiter 20, tenuibus; cymis solitariis vel fasciculatis, plerumque e axillis defoliatis, 4 ad 6 cm longis, breviter pedunculatis vel e basi ramosis, laxis, ramis plerumque 3-floris, floribus omnibus pedicellatis, calycis tubo circiter 1 cm longo, cuneato, lobis 4, petalis circiter 1 cm diametro, staminibus circiter 2 cm longis, fructibus junioribus urceolatis.

An erect glabrous shrub 2 to 3 m high, the branches and branchlets terete, the former pale gray, the latter reddish brown and 3 to 4 mm in diameter. Leaves lanceolate, opposite, subcoriaceous, olivaceous and scarcely shining when dry, 14 to 20 cm long, 2 to 3.5 cm wide, subequally narrowed to the cuneate base and to the somewhat acuminate apex, the lower surface slightly paler than the upper and it and also often the upper surface conspicuously glandular-punctate, the midrib strongly impressed on the upper surface, prominent on the lower surface; lateral nerves slender, about 20 on each side of the midrib, anastomosing with the equally slender marginal nerves 1 to 2 mm from the edge of the leaf; petioles reddish brown, 10 to 14 mm long. Cymes mostly from the axils of fallen leaves, solitary or fascicled, shortly peduncled, 4 to 6 cm long, few-flowered, the ultimate branches for the most part 3-flowered, the axis and branches distinctly glandular-punctate. Flowers 4-merous, white, their pedicels 7 to 10 mm long. Calyx tube about 1 cm long, terete, cuneate, the throat 5 to 7 mm in diameter, the lobes broadly rounded, persistent, and conspicuously glandular-punctate. Petals about 1 cm in diameter, very conspicuously glandular-punctate. Stamens numerous, about 2 mm long, white. Immature fruits distinctly urceolate.

MINDANAO, Zamboanga District, Malangas, *Bur. Sci. 36934* (type) *36935 Ramos & Edaño,* November, 1919. On river banks at low altitudes, apparently in situations subject to sudden overflows; locally known as *salimbañgon.*

A remarkably distinct species well characterized by its conspicuously glandular-punctate, elongated, lanceolate leaves, and

its lateral, rather lax, few-flowered cymes, the flowers being comparatively rather large in size.

EUGENIA BESUKIENSIS (Hassk.) Merr. in Journ. Str. Branch Roy. As. Soc. 77 (1917) 226.

Microjambosa besukiensis Hassk. ex Miq. Fl. Ind. Bot. Suppl. (1861) 311, in syn.

Jambosa buxifolia Miq. Fl. Ind. Bot. 1 (1858) 1086, Suppl. (1861) 311, non *Eugenia buxifolia* Willd.

MINDORO, Mount Calavite, *Bur. Sci. 39440 Ramos,* April, 1921. On forested slopes, altitude about 600 meters. Borneo, Bangka. The specimens exactly match our comprehensive series of specimens from Borneo and Bangka. New to the Philippines.

ARALIACEAE

SCHEFFLERA Forster

SCHEFFLERA BUKIDNONENSIS sp. nov. § *Heptapleurum.*

Frutex scandens, glaber, ramulis circiter 5 mm diametro; foliis 8-foliolatis, foliolis subcoriaceis, lanceolatis, integris, 6 ad 9 cm longis, olivaceis, nitidis, caudato-acuminatis, basi cuneatis, nervis utrinque 5 vel 6, tenuibus; inflorescentiis circiter 30 cm longis, ramis primariis numerosis, patulis, 9 ad 18 cm longis, floribus umbellatis, umbellis 6- ad 8-floris, in ramis primariis racemose dispositis; floribus 5-meris, pedicellatis; fructibus subellipsoideis, 4 ad 5 mm longis, 5-locellatis, leviter sulcatis.

A glabrous scandent shrub, the branches blackish brown when dry, about 5 mm in diameter, with few lenticels. Leaves 8-foliolate, their petioles about 10 cm long, rather slender; leaflets lanceolate, entire, subcoriaceous, olivaceous, shining, 6 to 9 cm long, 1.5 to 2.5 cm wide, subequally narrowed to the caudate-acuminate apex and to the cuneate base; lateral nerves 5 or 6 on each side of the midrib, slender; petiolules 1.5 to 2 cm long. Inflorescences terminal, about 30 cm long, the primary branches alternate along the greatly elongated rachis, spreading, the lower ones up to 18 cm long, the upper ones gradually shorter, the uppermost 7 to 9 cm long; umbels 6- to 8-flowered, racemosely arranged on the primary branches, their peduncles 5 to 7 mm long, the pedicels 3 to 5 mm in length. Fruits subellipsoid, 5-celled, 4 to 5 mm long, brown when dry, slightly sulcate, the filaments rather long-persistent, 2 to 3 mm long.

MINDANAO, Bukidnon Subprovince, Mount Candoon, *Bur. Sci. 38737 Ramos & Edaño,* June 27, 1920. Climbing on trees on forested slopes at an altitude of about 1,600 meters.

A species not closely allied to any previously known Philippine form, well characterized by its lanceolate, caudate-acuminate, long-petiolulate, comparatively small, entire leaves and by its ample inflorescences, the spreading primary branches being racemosely arranged along the elongated axis.

SCHEFFLERA HALCONENSIS sp. nov. § *Heptapleurum.*

Frutex glaber, ramulis lenticellatis, circiter 5 mm diametro; foliis 5-foliolatis, foliolis oblongo-ellipticis, coriaceis, rigidis, atro-olivaceis, subtus pallidioribus, integris, 8 ad 15 cm longis, acute acuminatis, basi acutis, plerumque plus minusve inaequilateralibus, brevissime petiolulatis, nervis utrinque 13 ad 15, tenuibus, admodum subobsoletis; inflorescentiis breviter pedunculatis, ramis primariis plerumque 3, elongatis, circiter 20 cm longis, deorsum nudis, floribus umbellatis, umbellis paucis, 5- ad 7-floris, racemose dispositis; fructibus 6-locellatis, late ovoideis, 5 mm longis, leviter sulcatis.

A glabrous shrub, the branches terete, about 5 mm in diameter, lenticellate. Leaves 5-foliolate, their petioles 4 to 7 cm long, rather stout; leaflets oblong-elliptic, coriaceous, rigid, the upper surface dark olivaceous when dry, the lower surface much paler, slightly shining, 8 to 15 cm long, 4 to 6 cm wide, the apex slightly acuminate, base acute, margins entire; lateral nerves very slender, 13 to 15 on each side of the midrib, often scarcely visible, the reticulations obsolete; petiolules 3 to 8 mm long. Inflorescences shortly peduncled, usually bearing three primary elongated branches about 20 cm in length, these floriferous only in the upper one-half, the umbels racemosely arranged, 5- to 7-flowered, the peduncles about 1 cm long, the pedicels 3 to 5 mm long. Fruits orange-red, broadly ovoid, 6-celled, about 5 mm long, slightly sulcate.

MINDORO, Mount Halcon, *Merrill 5696*, November, 1906. In damp primary forests at an altitude of about 900 meters.

A species well characterized by its brittle, obscurely nerved leaflets and its shortly peduncled inflorescences bearing usually three elongated primary branches which bear a few racemosely disposed umbels in the upper part. The material was collected from an erect shrub about 1 m high; in age the plant doubtless becomes more or less scandent.

SCHEFFLERA CINNAMOMEA sp. nov. § *Cephaloschefflera.*

Arbor erecta (vel scandens?), inflorescentiis junioribus dense furfuraceis; foliis circiter 12-foliolatis, longissime petiolatis, petiolo glabro, circiter 70 cm longo, foliolis oblongis ad oblongo-

ellipticis, crasse coriaceis, 25 ad 30 cm longis, integris, breviter acuminatis, basi rotundatis, supra olivaceis, nitidis, subtus cinnamomeis, junioribus parce stellato-pubescentibus, vetustioribus glabris, nervis utrinque circiter 12, valde perspicuis, reticulis distinctis, petiolulis 6 ad 10 cm longis; inflorescentiis (vel ramis primariis) crassis, circiter 80 cm longis, furfuraceis, capitulus globosis, 1.5 ad 1.8 cm diametro, racemose dispositis; fructibus junioribus 5 mm longis, dense adpresse-hirsutis, 5-6-sulcatis, calycis limbo truncato, glabro, 3 mm diametro.

A tree or a coarse scandent vine, the younger parts of the inflorescences densely furfuraceous. Branches not seen. Petioles stout, dark reddish brown when dry, about 70 cm long and 1 cm in diameter, glabrous; leaflets about 13, oblong to oblong-elliptic, thickly coriaceous, 25 to 30 cm long, 10 to 12 cm wide, entire, the upper surface glabrous, shining, brownish olivaceous, the lower surface cinnamomeus and usually with scattered short stellate hairs, ultimately glabrous or nearly so, the apex shortly acuminate, base rounded; lateral nerves 10 to 12 on each side of the midrib, very prominent on the lower surface, the reticulations distinct; petiolules minutely furfuraceous, 6 to 10 cm long. Inflorescences (or primary branches of the inflorescences) stout, racemose, about 80 cm long, the upper parts densely furfuraceous, the indumentum pale brownish, the lower parts sparingly furfuraceous, ultimately nearly glabrous, each inflorescence or branch bearing about 30 racemosely arranged globose heads 1.5 to 1.8 cm in diameter, their peduncles furfuraceous, about 1 cm long or the uppermost ones shorter, each peduncle subtended by a deciduous bract, the persistent bracts on the lower part of the rachis oblong-ovate, thickly coriaceous, 2.5 to 3 cm long. Fruits densely crowded, about 5 mm long, 3 mm in diameter, 5- or 6-celled, more or less sulcate, narrow, pale, the tube densely appressed-hirsute, the projecting calyx rim truncate, glabrous; each fruit subtended by a single bract and two bracteoles, the former ovate, 5 mm long, the latter lanceolate, acuminate, glabrous, about 4 mm in length.

MINDANAO, Bukidnon Subprovince, Mount Candoon, *Bur. Sci. 38907 Ramos & Edaño*, July, 1920. In the mossy forest at an altitude of about 1,700 meters. Local name *kamang-kamang*.

This species resembles *Schefflera apoensis* Elm., but is readily distinguished from it and from other more or less allied forms by its very densely hirsute calyx tube, the projecting calyx rim being glabrous but surrounded by a fringe of hairs projecting from the calyx tube.

ARTHROPHYLLUM Blume

ARTHROPHYLLUM CENABREI sp. nov.

Arbor glabra, circiter 10 m alta, ramulis ultimis circiter 5 mm diametro; foliis superioribus usque ad 10 cm longis, 3- ad 5-foliolatis, vel ultimis 1-foliolatis, foliolis plerumque ellipticis, 4.5 ad 6 cm longis, brevissime obtuse acuminatis, brunneo-olivaceis, nitidis, chartaceis vel subcoriaceis, nervis utrinque 3 vel 4, tenuibus; pedunculis circiter 4 cm longis, pedicellis 8 mm longis, fructibus ovoideis, 7 mm diametro.

A glabrous tree about 10 m high, the ultimate branches about 5 mm in diameter. Upper leaves pinnate, up to 10 cm long, the leaflets mostly 5, sometimes 3, or the uppermost leaves reduced to simple leaflets, the rachis and petiole about 4 cm long, the leaflets mostly elliptic, 4.5 to 6 cm long, 2.5 to 3.5 cm wide, chartaceous to subcoriaceous, very shortly and obtusely acuminate, base acute, brownish olivaceous and slightly shining when dry; lateral nerves slender, 3 or 4 on each side of the midrib; petiolules 5 to 10 mm long. Peduncles about 4 cm long, umbellately arranged at the tips of the branchlets, usually, however, with solitary inflorescences in the axils of the uppermost leaves, thus forming a somewhat leafy inflorescence. Fruits 5 to 8 in each umbel, ovoid, about 7 mm in diameter, their pedicels 8 to 10 mm in length.

CEBU, Maraag, *For. Bur. 28343 Cenabre & de la Cruz,* March 12, 1921. On slopes at an altitude of about 600 meters. Local name *bingleu.*

A species well charactized by its small leaflets which are gradually reduced in number, at least on the uppermost branchlets. In general this species seems to be most closely allied to *Arthrophyllum pulgarense* Elm. but is at once distinguishable by its very few leaflets.

ALANGIACEAE

ALANGIUM Lamarck

ALANGIUM PILOSUM sp. nov. § *Marlea.*

Arbor circiter 18 m alta, subtus foliis et ramulis inflorescentiisque dense molliter fulvo-pubescentibus; foliis inaequilateralibus, chartaceis, oblongo-ovatis vel oblongo-lanceolatis, valde subtenuiter acuminatis, usque ad 13 cm longis, penninerviis; cymis axillaribus, solitariis, circiter 5 cm longis; fructibus circiter 8 mm longis, ovoideis vel ovoideo-ellipticis, parce pubescentibus.

A tree about 18 m high. Branches terete, densely fulvous-pubescent as are the branchlets, inflorescences, and under sur-

faces of the leaves. Leaves entire, chartaceous, oblong-ovate to oblong-lanceolate, 8 to 13 cm long, 3 to 4.5 cm wide, inequilateral, the base rounded on one side, acute on the other, the apex slenderly acuminate, the acumen often somewhat falcate, the upper surface brown, somewhat pubescent on the midrib and nerves, ultimately nearly glabrous, the lower rather densely and softly pubescent with short fulvous hairs; nerves 6 or 7 on each side of the midrib, curved-ascending; petioles densely and softly fulvous-pubescent, 5 to 8 mm long. Inflorescences of axillary, peduncled, solitary, softly fulvous-pubescent cymes 4 mm wide or less, the peduncles about 2 cm long. Fruits about 8 mm long, ovoid or ovoid-ellipsoid, slightly pubescent, brown when dry, crowned by the more densely pubescent calyx rim.

LUZON, Rizal Province, *For. Bur. 3307 Ahern's collector* (type), September, 1905, *Loher 6229*. A less-pubescent form is represented by *Bur. Sci. 32715 Ramos* and *For. Bur. 32608 Paraiso*, from Ilocos Norte Province, Luzon, July, 1918, and January, 1915.

Var. **SUBGLABRUM** var. nov.

A type differt foliis glabris vel subglabris.

Flowers white. Ovary pubescent, 1 mm long, the limb produced about 1 mm above the ovary, truncate or very obscurely toothed. Petals 6 or 8, pubescent, about 5 mm long, 1 mm wide, often connate in pairs, the flower then appearing as 3- or 4-merous. Stamens 6 or 8, 4 mm long. Style 4 mm long, the arms 2, 1 mm long, glabrous, linear.

NEGROS, *For. Bur. 23399 Contreras*, July 14, 1914. In rocky places on slopes, altitude about 300 meters.

This species is most closely allied to *Alangium vitiense* Harms as Wangerin has arranged the species. It is distinguished by its small flowers. Local names are *malabulau* (Tag.) and *pangagrauen* (Ilk.).

ERICACEAE

DIMORPHANTHERA F. Mueller

DIMORPHANTHERA MINDANAENSIS sp. nov.

Species D. apoanae Schltr. affinis differt floribus glabris.

A shrub, entirely glabrous except the bracts inclosing the inflorescences, the branches and branchlets rather stout, reddish brown when dry or sometimes nearly black. Leaves thickly coriaceous, ovate to elliptic, brownish when dry, 4 to 8 cm long, 2.5 to 4.5 cm wide, somewhat shining, the apex shortly acumin-

ate, the base acute to rounded and usually 5-nerved, sometimes with an additional pair of slender marginal nerves, the inner nerves leaving the midrib 4 to 8 mm above the base, the reticulations rather lax; petioles 4 to 8 mm long, rather stout. Flowers fascicled in the uppermost axils, the young buds entirely inclosed by numerous, imbricate, brown, sparingly pubescent, concave bracts forming a cylindric head about 1 cm in diameter, some of the bracts subpersistent, others deciduous. Pedicels up to 10 mm long. Calyx glabrous, about 3.5 mm long, shallowly 5-lobed, the lobes broadly ovate, shortly and abruptly acuminate. Corolla red, 8 to 10 mm long, glabrous, somewhat widened upward, the lobes ovate, about 3 mm long. Stamens 10, glabrous, dimorphous, the larger ones with filaments and anthers about 4 mm long, the shorter ones with filaments 3 mm long and anthers about 2 mm long. Styles 12 mm long, glabrous. Fruits unknown.

MINDANAO, Misamis Province, Mount Malindang, *For. Bur. 4708 Mearns & Hutchinson,* May, 1906. In the mossy forest, altitude about 1,700 meters. The same species is apparently represented by *Bur. Sci. 38537 Ramos & Edaño* from Mount Lipa, Bukidnon Subprovince, Mindanao, July, 1920.

Both specimens were originally identified as *Vaccinium apoanum* Merr.=*Dimorphanthera apoana* Schltr. but, like that species, are true representatives of the genus *Dimorphanthera,* differing from the latter especially in the glabrous flowers. It is the second species of the genus to be found in the Philippines, *Dimorphanthera* being now known otherwise only from New Guinea and Amboina, with twenty-seven species in New Guinea and one in Amboina.

EPACRIDACEAE

STYPHELIA Smith

STYPHELIA PHILIPPINENSIS sp. nov.

Frutex vel suffrutex 0.5 ad 3 m altus, ramis ramulisque numerosis, valde rugosis, ramulis puberulis; foliis numerosis, confertis, rigidis, acute acuminatis, anguste lanceolatis, 7 ad 13 mm longis, 1 ad 2 mm latis, brevissime petiolatis, supra olivaceis, subtus glaucis; floribus terminalibus, bracteis bractiolisque late ovatis, subacutis, 2 mm longis; sepalis 5, ovatis, 3 mm longis, corollae lobis intus villosis; fructibus in siccitate rugosis, 3 ad 4 mm diametro, putamine 4-loculare.

A much-branched, rather rigid undershrub or shrub, 0.5 to 3 m high, the branches and branchlets rugose from the numerous conspicuous pulvini of fallen leaves. The ultimate branchlets somewhat puberulent. Leaves very numerous, crowded, imbricate, rigid, narrowly lanceolate, sharply acuminate, 7 to 13 mm long, 1 to 2 mm wide, the upper surface smooth, olivaceous, shining, the lower surface glaucous, longitudinally striate, the petiole about 0.5 mm long. Flowers terminal, few to many, crowded, the spikelike inflorescence up to 1 cm long and 5 mm in diameter. Flowers white, the bracts broadly ovate, acute or somewhat obtuse, concave, the margins slightly pubescent, about 2 mm long, the bracteoles similar. Sepals 5, ovate, about 3 mm long, acute, their margins slightly ciliate. Corolla tube rather slender, glabrous, about 2 mm long, the lobes 5, narrowly lanceolate, acuminate, as long as the tube, spreading, villous on the inside. Ovary subglobose, glabrous, the style about 1 mm long. Fruit globose, somewhat fleshy, white, pink or red when fresh, when dry rugose, 3 to 4 mm in diameter, the putamen hard, 4-celled, the cells 1-seeded.

LUZON, Benguet Subprovince, between Suyoc and Pauai, *Merrill 4762,* November 7, 1905, on exposed ridges, altitude about 2,200 meters, *For. Bur. 1443 Darling,* January, 1909. NEGROS, Canlaon Volcano, *Merrill Philip. Pl. 243* (type), April, 1910, a shrub up to 3 m high in the mossy thickets on exposed ridges but here not common, abundant in open places on the old crater ascending to an altitude of about 2,000 meters, often flowering when less than 0.5 m high. MINDANAO, Davao Subprovince, Mount Apo, *Copeland 1040, 1419,* April and October, 1904, *De Vore & Hoover 313, 379,* May, 1903, *Elmer 11389.*

The specimens have been referred to the Bornean *Styphelia suaveolens* (Hook. f.) J. J. Sm., the identification having been based largely on published descriptions. The species is manifestly allied to the Bornean form but abundant material from Mount Kinabalu, the type locality of the latter species, shows that the Philippine form differs in a number of details, notably in its much longer, differently shaped, sharply acuminate leaves and shorter petioles, and I am now of the opinion that it should be considered specifically distinct. Doctor Copeland notes that on Mount Apo this, with *Vaccinium villarii* Vid.=*V. myrtoides* Miq., is the dominant shrub on the upper 200 meters of the mountain, ascending to the summit at an altitude of 2,820 meters.

MYRSINACEAE

Mez [3] has recently proposed numerous new species of Myrsinaceae, but most of those based on Philippine material had previously been amply described. Of the twenty-four species described from Philippine material I unhesitatingly reduce the following eighteen. In a number of cases Mez's type specimen is of the same collection as the types of previously described forms. Additional study may show that *Ardisia macropus* Mez is not sufficiently distinct from *A. saligna* Mez, and that *Jubilaria radlkoferi* Mez is not distinct from *Embelia porteana* Mez. The following reductions must be made:

Maesa grossedentata Mez in Fedde Repert. **16** (1920) 309 = *M. laxa* Mez.

Maesa piscatorum Mez l. c. = *M. gaudichaudii* A. DC.

Maesa lobuligera Mez op. cit. 310 = *M. megaphylla* Merr. in Philip. Journ. Sci. **12** (1917) Bot. 158.

Ardisia cincta Mez op. cit. 312 = *A. marginata* Blume.

Ardisia milleflora Mez op. cit. 410 = *A. diffusa* Merr. in Philip. Journ. Sci. **5** (1910) Bot. 216.

Ardisia lanaensis Mez op. cit. 411 = *A. clementis* Elm. Leafl. Philip. Bot. **2** (1910) 665.

Ardisia negroënsis Mez l. c. = *A. squamulosa* Presl.

Ardisia glauca Mez op. cit. 412 = *A. geissanthoides* Mez l. c.!

Ardisia magnifica Mez op. cit. 413 = *A. romanii* Elm. Leafl. Philip. Bot. **5** (1913) 1820.

Ardisia palawanensis Mez l. c. = *A. palawanensis* Merr. in Philip. Journ. Sci. **5** (1910) Bot. 220.

Ardisia dataënsis Mez op. cit. 414 = *Ardisia curtipes* Merr. in Philip. Journ. Sci. **5** (1910) Bot. 372.

Ardisia membranifolia Mez op. cit. 415 = *Ardisia warburgiana* Mez.

Ardisia reptans Mez l. c. = *A. reptans* Merr. in Philip. Journ. Sci. **5** (1910) Bot. 416.

Discocalyx dolichopus Mez op. cit. 417 = *D. montana* Elm. Leafl. Philip. Bot. **2** (1908) 443.

Discocalyx crenulatus Mez op. cit. 418 = *D. montana* Elm.

Jubilaria magnolifolia Mez op. cit. 421 = *Loheria bracteata* Merr. in Philip. Journ. Sci. **5** (1910) Bot. 374.

Embelia latifolia Mez op. cit. 422 = *Embelia nigropunctata* Merr. in Philip. Journ. Sci. **7** (1912) Bot. 326.

Rapanea peregrina Mez op. cit. 424 = *Rapanea venosa* Elm. Leafl. Philip. Bot. **2** (1910) 672.

[3] Mez, C., Additamenta monographica 1919. III Myrsinaceae, Fedde Repert. **16** (1920) 309–312; 410–425.

MAESA Forskål

MAESA MEGALOBOTRYA sp. nov.

Frutex scandens, inflorescentiis obscure puberulis exceptis glaber, ramis circiter 5 mm diametro, brunneis, lenticellatis; foliis ovatis, chartaceis, 14 ad 16 cm longis, acuminatis, basi late rotundatis, margine grosse crenatis; inflorescentiis terminalibus, paniculatis, circiter 50 cm longis, multifloris; floribus 5-meris, calycis lobis ovatis, integris, circiter 0.8 mm longis, haud lineatis, glabris, corolla 1.5 mm longa, lobis late orbiculari-ovatis, usque ad ½ connatis, rotundatis, haud lineatis; bracteolis ovatis, acutis vel acuminatis, 1 mm longis.

A scandent shrub, glabrous except the obscurely puberulent inflorescences. Branches about 5 mm in diameter, terete, dark brown, lenticellate. Leaves ovate, chartaceous, pale olivaceous when dry, somewhat shining, the lower surface brownish, 14 to 16 cm long, 8 to 9 cm wide, acuminate, the acumen minutely apiculate, base broadly rounded, margins coarsely crenate; lateral nerves 7 or 8 on each side of the midrib, rather prominent, the reticulations not distinct; petioles about 2 cm long. Panicles terminal, about 50 cm long, the lower branches 20 to 30 cm long, the lowermost ones subtended by reduced leaves, these from 4 to 8 cm in length. Flowers very numerous, racemosely disposed on the ultimate branchlets, their pedicels about 1 mm long, in fruit up to 2 mm in length, the bracts ovate, 1.5 mm long, slenderly and conspicuously acuminate, slightly puberulent, the bracteoles broadly ovate, acute or acuminate, 1 mm long. Calyx lobes 5, ovate, acute, 0.8 mm long, not at all lineate, entire, glabrous, their margins not ciliate. Corolla about 1.5 mm long, the lobes broadly orbicular-ovate, rounded, extending about one-half to the base of the corolla, not lineate. Stamens inserted near the base of the corolla, the filaments less than 1 mm long. Immature fruits subellipsoid, about 2.5 mm long, not glandular.

PALAWAN, Taytay, *Merrill 9176*, April, 1913. In thickets at an altitude of about 10 meters.

A species well characterized by its unusually large terminal panicles. It is apparently closest to *Maesa paniculata* A. DC. and among the Philippine forms belongs in the group with *Maesa cumingii* A. DC., although remote from the latter species.

MAESA UNDULATA sp. nov.

Frutex scandens, inflorescentiis obscure puberulis exceptis glaber, ramis brunneis, lenticellatis; foliis ovatis, brunneis, distincte reticulatis, chartaceis, nitidis, 9 ad 13 cm longis, acuminatis, basi

rotundatis, margine leviter undulatis, cartilagineis; paniculis axillaribus, 10 ad 20 cm longis; floribus 5-meris, calycis glabris, lobis late ovatis, obtusis vel minute apiculatis, haud ciliatis, haud lineatis, corollae lobis late elliptico-ovatis, rotundatis, 1.4 mm longis, usque ad $\frac{1}{2}$ connatis, obscure lineatis; bracteolis ovatis, acuminatis, 0.8 mm longis.

A scandent shrub, glabrous except the inflorescences, which are obscurely puberulent. Branches brown, 4 to 5 mm in diameter, lenticellate, the ultimate branchlets about 2 mm in diameter, terete. Leaves ovate, chartaceous, 9 to 13 cm long, 5 to 7 cm wide, the upper surface brownish olivaceous, shining, the lower surface brown, the apex acuminate and slightly apiculate, the base broadly rounded, margins shallowly undulate, the edge of the leaf distinctly cartilaginous; lateral nerves 8 or 9 on each side of the midrib, rather prominent on the lower surface, the reticulations distinct, the ultimate ones plainly visible to the naked eye. Panicles axillary, ample, rather many-flowered, 10 to 20 cm long, the primary branches slender, usually spreading, up to 10 cm in length, the flowers racemosely disposed on the ultimate branches, white or nearly so. Flowers 5-merous, the bracts oblong-ovate, acute or acuminate, about 1 mm long, the bracteoles ovate, acuminate, 0.8 mm long, the pedicels 1 to 1.5 mm in length. Calyx glabrous, about 1.5 mm in diameter, eglandular, the lobes broadly ovate, often minutely apiculate, not lineate and not at all ciliate, entire. Corolla lobes broadly elliptic-ovate, rounded, about 1.4 mm long, extending to or below the middle of the corolla, obscurely lineate. Stamens inserted near the base of the corolla lobes, their filaments slender, 0.6 mm long.

LUZON, Tayabas Province, near Tagbilao, *Bur. Sci. 26872 Edaño*, March, 1917. In thickets or forests, apparently from low altitudes.

This species is probably most closely allied to *Maesa coriacea* Mez and among the Philippine species comes nearest to *Maesa megaphylla* Merr. from which it is distinguished, among other characters, by its undulate and distinctly reticulate leaves.

ARDISIA Swartz

ARDISIA CALAVITENSIS sp. nov. § *Tinus*.

Frutex glaberrimus, 1 m altus; foliis oblongis ad oblongo-ovatis, integris, 9 ad 12 cm longis, subcoriaceis, olivaceis, nitidis, obtusis vel breviter obtuseque acuminatis, basi cuneatis, utrinque distincte reticulatis, vix punctatis, nervis primariis utrinque 12

ad 15, tenuibus; petiolo 1.5 ad 2 cm longo; inflorescentiis racemoso-umbellatis, 3 ad 5 cm longis; sepalis usque ad $\frac{1}{3}$ connatis, orbicularis, rotundatis, 4 mm diametro, glabris, eglandulosis, margine haud ciliatis; petalis ovatis, obtusis, 9 mm longis, eglandulosis; connectivo haud glandulosis.

An entirely glabrous shrub, about 1 m high, the branches and branchlets brownish or grayish. Leaves oblong to oblong-ovate, entire, 9 to 12 cm long, 3 to 5 cm wide, subcoriaceous, olivaceous, shining, the apex obtuse to shortly and obtusely acuminate, the base cuneate, both surfaces distinctly reticulate, scarcely punctate-glandular; primary lateral nerves 12 to 15 on each side of the midrib, slender but distinct on both surfaces; petioles 1.5 to 2 cm long. Inflorescences lateral, simply umbellate-racemose, 3 to 5 cm long, the flowers somewhat crowded near the apex of the peduncle, their pedicels stout, 10 to 12 mm long. Sepals united for about one-third, orbicular, rounded, about 4 mm in diameter, glabrous, their margins not at all ciliate, eglandular. Petals pink, ovate, obtuse, about 9 mm long, 6 mm wide, eglandular. Anthers oblong-lanceolate, acuminate, 6 to 7 mm long, the connective not at all glandular.

MINDORO, Paluan and Mount Calavite, *Bur. Sci. 39435* (type) *39632 Ramos*, April, 1921. In primary forests up to an altitude of 600 meters.

A species in the alliance with *Ardisia pirifolia* Mez, from which it is at once distinguished by its longer petioles, its eglandular petals, and the distinct and rather distant primary nerves, the reticulations being distinct on both surfaces.

DISCOCALYX Mez

DISCOCALYX BRACHYBOTRYS sp. nov.

Frutex glaber, ramulis circiter 4 mm diametro; foliis sessilibus vel subsessilibus, oblongo-ellipticis ad late oblanceolatis, 9 ad 16 cm longis, integris, chartaceis, pallide olivaceis, utrinque subaequaliter angustatis, acuminatis, basi obtusis, subtus perspicue glanduloso-punctatis, nervis utrinque circiter 15, distinctis; inflorescentiis racemosis vel depauperato-paniculatis, 1 ad 1.5 cm longis, in ramis circiter 1 cm longis extra-axillaribus dispositis, ramis cicatricibus perspicuis instructis; floribus 5-meris, calycis petalisque perspicue atro-glandulosis, calycis lobis acutis vel obtusis; petalis elliptico-obovatis, 3 mm longis.

A glabrous shrub about 1 m high, the ultimate branches terete, reddish brown, about 4 mm in diameter. Leaves sessile or subsessile, oblong-elliptic to broadly oblanceolate, 9 to 16 cm long,

2.5 to 6 cm wide, entire, chartaceous, pale olivaceous when dry, subequally narrowed to the somewhat acuminate apex and abruptly obtuse base; the lower surface conspicuously glandular-punctate, especially near the margins, the glands often nearly black; lateral nerves about 15 on each side of the midrib, slender, distinct as are the reticulations. Inflorescences very short, racemose or depauperate-paniculate, 1 to 1.5 cm long, one to several, from the tip of the short, specialized, extra-axillary, lateral branches, these specialized branches 1 cm long or less, about 2 mm in diameter, marked with numerous, conspicuous scars of fallen peduncles, the apical bracts lanceolate, acuminate, 3 to 4 mm long. Flowers 5-merous, their pedicels up to 2 mm long. Calyx and corolla very conspicuously black-glandular, the calyx lobes triangular-ovate, acute or obtuse, 0.8 mm long. Petals elliptic-obovate, obtuse, 3 mm long. Filaments and anthers each about 1 mm long. Ovary equaling the style in length, glandular.

MINDANAO, Zamboanga District, *Bur. Sci. 37463 Ramos & Edaño*, December, 1919. Along streams in forests at low altitudes.

A species allied to *Discocalyx sessilifolia* Merr. but with thinner, rather slenderly acuminate, prominently glandular-punctate leaves, and with very much shorter inflorescences.

DISCOCALYX PHANEROPHLEBIA sp. nov.

Frutex erectus, simplex, caulis sursum 1.5 ad 2 cm diametro; foliis oblanceolatis ad oblongo-oblanceolatis, 45 ad 60 cm longis, coriaceis, olivaceis, acutis, deorsum angustatis, margine deorsum integris, sursum dentatis vel crenato-dentatis, costa subtus valde incrassata, nervis utrinque circiter 20, supra impressis, subtus valde perspicuis; infructescentiis paniculatis, 2.5 ad 6 cm longis, in ramis specialibus lateralibus incrassatis 5 ad 10 cm longis dispositis; fructibus globosis, 8 mm diametro, calycis persistentibus 5-meris, 3 mm diametro, lobis late ovatis, obtusis, glanduloso-punctatis.

An erect, apparently unbranched, glabrous shrub 1 to 2 m high, the leaves crowded near the apex of the trunk, the stem here 1.5 to 2 cm in diameter. Leaves oblanceolate to oblong-oblancolate, 45 to 60 cm long, coriaceous, the upper surface olivaceous when dry, the lower surface much paler and not, or very inconspicuously, punctate, the apex acute, gradually narrowed below to the long-decurrent base, the margins in the lower one-fourth to one-third entire, above rather closely dentate or crenate-dentate, the teeth small; midrib very prominent on

the lower surface, in the lower part of the leaf 5 to 6 mm in diameter, the midrib and nerves impressed on the upper surface, the nerves 20 or more on each side of the midrib, very prominent on the lower surface as are the primary reticulations; petioles stout, 3 to 5 cm long, 5 to 7 mm in diameter, the lamina sometimes very narrowly decurrent almost to the base. Infructescences panicled, crowded at the apex of specialized lateral branches, these specialized branches from the axils of leaves or of fallen leaves, stout, 5 to 10 cm long, more or less thickened upward, the apical part supplied with numerous conspicuous scars of fallen panicles, the bracts lanceolate, acuminate, up to 1 cm long, deciduous. Panicles in fruit 2.5 to 6 cm long; pedicel in fruit stout, about 3 mm long. Flowers 5-merous, the persistent calyx 3 mm in diameter, the lobes broadly ovate, obtuse, glandular-punctate, glabrous, 0.6 mm long. Fruit globose, black when dry, about 8 mm in diameter.

MINDANAO, Bukidnon Subprovince, Manilupa River and Mount Candoon, *Bur. Sci. 38690* (type), *38792 Ramos & Edaño*, June and July, 1920. In forests along streams, altitude 1,200 to 1,400 meters.

A species belonging in the same group with, and closely allied to, *Discocalyx insignis* Merr., differing especially in its narrower leaves.

EMBELIA Burman f.

EMBELIA ELLIPTICA sp. nov. § *Euembelia.*

Frutex scandens, inflorescentiis puberulis exceptis glaber, ramulis 3 mm diametro; foliis ellipticis, integris, coriaceis, olivaceis, nitidis, 7 ad 11 cm longis, brevissime et latissime obtuse acuminatis, basi rotundatis, nervis utrinque circiter 15, patulis, distinctis, reticulis utrinque valde perspicuis; paniculis terminalibus, circiter 25 cm longis, multifloris; floribus 5-meris, calycis puberulis, 2 mm diametro glandulis paucis conspicuis instructis, lobis triangulari-ovatis, acutis, margine leviter ciliatis, petalis intus papilloso-puberulis, ellipticis, 2 ad 2.2 mm longis, glandulis paucis instructis, connectivo in ½ superiore parte glanduloso.

A scandent shrub, glabrous except the inflorescences, the branches and branchlets lenticellate, reddish brown, the former up to 1 cm in diameter, the latter 3 to 4 mm in diameter. Leaves elliptic, coriaceous, olivaceous, shining, 7 to 11 cm long, 5 to 6 cm wide, the apex very shortly and obtusely acuminate, the base rounded, margins entire, the lower surface paler than the upper and with rather conspicuous black glands; lateral nerves

about 15 on each side of the midrib, spreading, these and the ultimate reticulations projecting and very distinct on both surfaces; petioles about 1 cm long. Panicles terminal, about 25 cm long, the flowers racemosely arranged on the ultimate branchlets, the younger parts of the inflorescences more or less puberulent, the ultimate branchlets up to 5 cm in length. Flowers white, 5-merous, their pedicels about 0.5 mm long, the bracts ovate, nearly as long as the pedicels. Calyx puberulent, 2 mm in diameter, shallowly 5-lobed, with few brown, conspicuous glands, the lobes triangular-ovate, acute, 0.5 mm long and as broad as long, the margins slightly ciliate. Petals oblong-elliptic, 2 to 2.2 mm long, nearly glabrous outside, inside rather densely papillate-puberulent, the glands few, brown, conspicuous. Filaments 2 mm long, glabrous, the connectives glandular in the upper one-half.

MINDANAO, Bukidnon Subprovince, near Tankulan, *Bur. Sci. 39069 Ramos & Edaño,* July 20, 1920. In thickets along streams at an altitude of about 900 meters; locally known as *kalumai.*

This species belongs in the group with *Embelia javanica* A. DC. and among the Philippine forms is apparently most closely allied to *Embelia urdanetensis* Elm., from which it is distinguished by its larger, differently shaped leaves, which are rounded and not acute at the base.

EMBELIA LUZONIENSIS sp. nov. § *Pattara.*

Frutex scandens, inflorescentiis exceptis glaber; ramis 2 mm diametro; foliis oblongo-ovatis ad elliptico-ovatis, 5.5 ad 8 cm longis, chartaceis, utrinque angustatis, apice obtusis ad obscure obtuse acuminatis, basi acutis, in siccitate brunneis, subtus pallidioribus et plus minusve punctatis, nervis utrinque circiter 8, perspicuis; inflorescentiis plerumque axillaribus, racemosis, solitariis vel binis, circiter 2 cm longis, brunneo-glanduloso-pubescentibus; floribus manifeste pedicellatis, 5-meris, sepalis oblongis, 1 mm longis, glandulosis, pubescentibus; petalis ellipticis, symmetricis, rotundatis, 2 mm longis, glabris, glandulis paucis perspicuis instructis; filamentis glabris, 3 mm longis.

A scandent shrub, glabrous except the inflorescences, branches slender, terete, brown, about 2 mm in diameter, obscurely lenticellate. Leaves oblong-ovate to elliptic-ovate, 5.5 to 8 cm long, 3 to 4 cm wide, subequally narrowed to the obtuse or obscurely and obtusely acuminate apex and to the acute base, dark brown when dry, scarcely shining, the lower surface paler than the upper and distinctly glandular-punctate especially near

the margins, the glands very obscure on the upper surface; lateral nerves about 8 on each side of the midrib, curved-anastomosing, obscure on the upper surface, rather prominent on the lower surface, the reticulations not conspicuous; petioles 5 to 7 mm long. Racemes mostly axillary on the ultimate branchlets, solitary or in pairs, 1 to 2 cm long, rather many-flowered, the axis and pedicels glandular-pubescent with brown hairs. Flowers white, 5-merous, their pedicels slender, about 4 mm long, the bracts linear, 1 mm long. Sepals 5, nearly free, oblong, about 1 mm long, acute, glandular, pubescent. Petals elliptic, symmetrical, rounded, glabrous, about 2 mm long, with few conspicuous black glands. Filaments glabrous, 3 mm long.

LUZON, Nueva Vizcaya Province, Dupax, *Bur. Sci. 20098 McGregor*, January, 1913.

This species is apparently as closely allied to *Embelia tsjeriam-cottan* A. DC. as to any other, but differs in numerous details.

EMBELIA OVATIFOLIA sp. nov. § *Pattara.*

Frutex scandens, inflorescentiis exceptis glaber, ramulis 1.5 mm diametro; foliis ovatis, chartaceis, 6 ad 8 cm longis, olivaceis, nitidis, acuminatis, basi late rotundatis, utrinque glandulis perspicuis instructis, nervis utrinque circiter 10, perspicuis; racemis axillaribus, solitariis, binis vel trinis, circiter 2 cm longis, pubescentibus; floribus perspicue pedicellatis, 5-meris, calycis lobis ovatis, acutis vel obtusis, 0.6 mm longis, margine obscure ciliatis, glandulis paucis magnis perspicuis instructis; fructibus globosis, 4 ad 5 mm diametro.

A scandent shrub, glabrous except the glandular-pubescent racemes, the branches mostly grayish, about 5 mm in diameter, obscurely lenticellate, the branchlets slender, 1.5 mm in diameter, brownish. Leaves ovate, chartaceous, olivaceous, shining, 6 to 8 cm long, 4 to 5 cm wide, entire, the apex obtusely acuminate, the base broadly rounded, both surfaces conspicuously glandular, the glands black; lateral nerves about 10 on each side of the midrib, slender, distinct; petioles 8 to 10 mm long. Racemes axillary, solitary or in pairs or in threes, about 2 cm long, the pedicels 3 or 4 mm long, pubescent, the bracts lanceolate-acuminate from a broad base, puberulent, about 1 mm long, persistent. Calyx 2 mm in diameter, the lobes ovate, acute or obtuse, 0.6 mm long, with a few large and conspicuous, reddish glands in the upper one-half, the margin obscurely ciliate. Fruits globose, 4 to 5 mm in diameter.

MINDANAO, Bukidnon Subprovince, Mount Dumalupihan, *Bur. Sci. 39001 Ramos & Edaño,* July 29, 1920. On forested slopes, altitude about 1,200 meters.

A species manifestly belonging in the same group as *Embelia luzoniensis* Merr. and closely allied to that species. Among other characters it is easily distinguished by its very prominently glandular leaves, the black glands being conspicuous on both surfaces.

RAPANEA Aublet

RAPANEA ANGUSTIFOLIA sp. nov.

Frutex glaber; foliis numerosis, subcoriaceis, anguste oblongis ad lanceolatis, 4.5 ad 6 cm longis, 7 ad 10 mm latis, apice obtusis, basi acutis, in siccitate olivaceis, nitidis, subtus plus minusve glanduloso-punctatis, nervis inconspicuis; fructibus globosis, 3 mm diametro, in $\frac{1}{3}$ superiore parte perspicue atro-glandulosis; floribus 4-meris, calycis lobis late ovatis, obtusis, perspicue glandulosis, margine ciliatis.

A glabrous shrub about 3 m high, the branches terete, dark reddish brown. Leaves numerous, somewhat crowded, subcoriaceous, narrowly oblong to lanceolate, 4.5 to 6 cm long, 7 to 10 mm wide, the apex obtuse, base acute, the upper surface olivaceous, shining, the lower surface paler and more or less glandular-punctate, the glands nearly black, especially conspicuous along the margins; lateral nerves about 10 on each side of the midrib, slender, inconspicuous; petioles 3 to 4 mm long. Fruits globose, about 3 mm in diameter, conspicuously glandular in the upper one-third, the glands black. Pedicels 2 mm long. Flowers 4-merous, the persistent calyx rather conspicuously glandular, the lobes broadly ovate, obtuse, the margins more or less ciliate.

LUZON, Ilocos Norte Province, Mount Magatapan, *Bur. Sci. 33243 Ramos,* August 8, 1918, on slopes apparently at an altitude of about 1,000 meters. The same species is represented by a sterile specimen from Mount Piao collected by *Merritt & Darling* in November, 1908.

A species belonging in the group with *Rapanea philippinensis* Mez, but distinguished by its smaller, narrower leaves and by its conspicuously glandular-punctate fruits.

RAPANEA OBLONGIBACCA sp. nov.

Frutex glaber; foliis chartaceis ad subcoriaceis, oblongis ad oblongo-lanceolatis, in siccitate brunneis, nitidis, 3 ad 6 cm longis, 0.8 ad 1.8 cm latis, utrinque angustatis, apice acutis vel obtusis,

basi cuneatis, subtus plus minusve glandulosis, nervis inconspicuis; fructibus axillaribus, plerumque solitariis, oblongo-ovoideis, 5 ad 7 mm longis, apice glanduloso-punctatis; floribus 5-meris, calycis persistentibus, 3 mm diametro, lobis ovatis, acutis, perspicue glandulosis, margine ciliatis.

A glabrous shrub or small tree about 3 m high, the branches and branchlets nearly black when dry, terete, the scars not prominent. Leaves chartaceous to subcoriaceous, oblong to oblong-lanceolate, usually dark brown when dry, shining, the lower surface much paler than the upper, 3 to 6 cm long, 0.8 to 1.8 cm wide, narrowed upward to the acute or obtuse apex and below to the cuneate base, more or less glandular-punctate, the glands conspicuous and closely arranged along the margins; lateral nerves very inconspicuous, 8 to 10 on each side of the midrib; petioles 2 to 3 mm long. Fruits axillary, mostly solitary, oblong-ovoid, 5 to 7 mm long, brown when dry, glandular-punctate with black glands at the apex, their pedicels 2.5 mm long. Flowers 5-merous, the persistent calyx 3 mm in diameter, the lobes ovate, acute, 1 to 1.2 mm long, conspicuously glandular, the margins ciliate.

LUZON, Ilocos Norte Province, *Bur. Sci. 33256* (type), *33311 Ramos*, August, 1918. On forested slopes, altitude about 1,000 meters.

A species strongly characterized among the Philippine forms by its oblong-ovoid rather than globose fruits.

SAPOTACEAE

MADHUCA Gmelin

MADHUCA PHILIPPINENSIS sp. nov.

Species M. betis valde affinis, differt foliis subtus glabris vel subglabris.

A tree reaching a height of about 25 m. Branches terete, more or less rugose, glabrous, the young branchlets usually densely ferruginous-pubescent. Leaves crowded at the apices of the branchlets, oblong-oblanceolate, chartaceous, 14 to 22 cm long, 4 to 8 cm wide, the upper surface glabrous, strongly shining, greenish olivaceous to brown-olivaceous when dry, the lower surface glabrous or slightly pubescent on the midrib, paler than the upper, the apex shortly acuminate, more or less narrowed below to the acute or somewhat obtuse base; lateral nerves about 18 on each side of the midrib, somewhat impressed on the upper surface, prominent on the lower surface; petioles rather

densely pubescent, 2.5 to 3.5 cm long; stipules linear, pubescent, caducous, 9 to 13 mm long. Flowers crowded on the ultimate branchlets with or just below the leaves, the pedicels and calyces densely and softly ferruginous-pubescent, the former 1.5 to 2 cm long. Calyx lobes 4, 2-seriate, oblong-elliptic, obtuse, about 12 mm long, 6 mm wide. Ovary glabrous, 10-celled. Petals and stamens not seen. Fruits oblong-ellipsoid, brown, obtuse, about 4 cm long.

LUZON, Camarines Province, Nabua, *For. Bur. 28399 Labitag*, April 30, 1921. In primary dipterocarp forest at an altitude of about 200 meters, with the local name *banites*. The same species is represented by *Merrill 2601* from Tayabas Province, Luzon, as well as by imperfect sterile specimens including seedlings collected by *Ware, Hagger,* and *Garcia* in Camarines and Tayabas Provinces. A sterile specimen from Cotabato District, Mindanao, collected by *Hutchinson,* undoubtedly represents the same species. Additional native names are *manilig* (Mag.); *betis* and *betis lalake* (Tag.).

This species is manifestly closely allied to *Madhuca betis* (Blanco) Merr. and several of the specimens cited above were originally referred to that species. *Madhuca betis,* however, has the leaves very densely and softly pubescent on the lower surface, while in the present species they are glabrous or nearly so on both surfaces.

OLEACEAE

LINOCIERA Swartz

LINOCIERA LONGIFOLIA sp. nov.

Arbor parva, glabra; foliis lanceolatis ad oblongo-lanceolatis, 22 ad 30 cm longis, 5 ad 7 cm latis, coriaceis, utrinque angustatis, basi plus minusve decurrento-acuminatis, apice obtusis, nervis utrinque 13 ad 15, tenuibus, anastomosantibus, reticulis subobsoletis; inflorescentiis axillaribus, solitariis, paniculatis, 4 cm longis, floribus subumbellatim dispositis, pedicellatis; calycis cupulatis, 1.5 mm diametro, breviter 4-lobatis, lobis triangulari-ovatis, acutis vel obtusis.

A glabrous tree about 10 m high, the branchlets distinctly compressed at the nodes. Leaves lanceolate to oblong-lanceolate, 22 to 30 cm long, 5 to 7 cm wide, coriaceous, rather pale when dry, opposite, entire, narrowed below to the somewhat decurrent-acuminate base and above to the obtuse apex, more or less verruculose; nerves 13 to 15 on each side of the midrib, slender, slightly projecting on the lower surface, anastomosing, the retic-

ulations very lax, often obsolete; petioles stout, 8 to 10 mm long. Inflorescences axillary, solitary, paniculate, about 4 cm long, the branches spreading, the lower ones 1 to 1.4 cm long, the flowers for the most part subumbellately arranged near the apices of the branches; bracts lanceolate, acuminate, slightly pubescent, 4 to 5 mm long; pedicels about 3 mm long. Calyx cup-shaped, about 1.5 mm in diameter, 4-lobed, the lobes triangular-ovate, acute or obtuse, less than 0.4 mm long. Corolla not seen. Ovary ovoid, glabrous; style 0.5 mm long.

MINDANAO, Lanao District, Bolut River, *For. Bur. 20626 Miranda,* June 14, 1913. In forests at sea level.

A species having more the general appearance of *Olea* than of *Linociera,* well characterized by its elongated leaves. When perfect flowers are available it may prove to belong to the former genus. Its alliance is manifestly with *Linociera philippinensis* Merr., from which it is at once distinguished by its vegetative characters.

LOGANIACEAE

GENIOSTOMA Forster

GENIOSTOMA ACUMINATISSIMA sp. nov.

Frutex glaber, ramis teretibus; foliis chartaceis, oblongo-ellipticis ad lanceolatis, nitidis, 8 ad 12 cm longis, utrinque angustatis, apice tenuiter caudato-acuminatis, basi cuneatis, nervis utrinque 8 ad 10; cymis tenuiter pedunculatis, axillaribus, solitariis, paucifloris, 2 ad 3 cm longis; floribus circiter 1 cm longis, intus villosis.

A glabrous shrub or small tree, the branches slender, terete, the branchlets black when dry. Leaves chartaceous, dark-colored when dry, shining, oblong-elliptic to lanceolate, 8 to 12 cm long, 2.5 to 4.5 cm wide, subequally narrowed to the cuneate base and to the slenderly caudate-acuminate apex; primary lateral nerves 8 to 10 on each side of the midrib, distinct, curved, anastomosing, the reticulations distinct, slender; petioles 3 to 5 mm long; stipules lanceolate, acuminate, 1.5 to 2 mm long. Cymes solitary, few-flowered, 2 to 3 cm long, the peduncles slender, up to 2 cm long, the pedicels 2 mm long. Flowers white, black when dry. Calyx about 2.2 mm long, somewhat urceolate, the teeth triangular, short. Corolla glabrous outside, villous inside, about 1 cm long, the tube 6 mm long, the lobes 4, oblong, obtuse, 4 mm long, villous inside. Style 8 mm long. Fruits about 8 mm long, black when dry, rugose, strongly ventricose, obtuse, base decurrent-acuminate.

MINDANAO, Bukidnon Subprovince, Mount Candoon, *Bur. Sci. 38837 Ramos & Edaño,* June 25, 1920. In damp forests, altitude about 1,000 meters.

A species strongly characterized by its lax, elongated, slenderly peduncled cymes and its caudate-acuminate leaves.

STRYCHNOS Linnaeus

STRYCHNOS CENABREI sp. nov. § *Penicillatae.*

Frutex scandens, ramulis et inflorescentiis et subtus foliis ad costa nervisque plus minusve ferrugineo-pubescentibus; foliis triplinerviis, chartaceis, olivaceis, nitidissimis, ellipticis ad oblongo-ellipticis, usque ad 12 cm longis, utrinque subaequaliter angustatis, apice acute acuminatis, basi acutis vel decurrentibus; cymis circiter 2 cm longis; floribus 6- vel 5-meris, circiter 3.5 mm longis, corollae lobi linea pilorum erectorum ad basin instructi, antherae filamenta in tubo corollae inserta; ovarium glabrum; antherae basi leviter barbatae; fructibus globosus, 1.5 cm diametro; seminibus solitariis.

A scandent woody vine, glabrous except the more or less ferruginous-pubescent branchlets, inflorescences, and younger leaves on the nerves beneath. Branches terete, dark-colored, glabrous, the younger branchlets about 1.5 mm in diameter, appressed ferruginous-pubescent with short, scattered hairs, ultimately glabrous or nearly so. Leaves elliptic to oblong-elliptic, chartaceous, 7 to 12 cm long, 3.5 to 5 cm wide, subequally narrowed to the acute or decurrent, 3-plinerved base and to the sharply acuminate apex, the upper surface olivaceous, strongly shining, the lower surface shining and when young more or less ferruginous-pubescent on the midrib and primary nerves, the basal nerves leaving the midrib 5 to 10 mm above the base of the leaf and extending nearly or quite to the apex, the reticulations distinct on both surfaces; petioles 5 to 7 mm long, ferruginous-pubescent, ultimately glabrous. Cymes axillary, ferruginous-pubescent, short-peduncled, in anthesis about 2 cm long, in fruit up to 3 cm in length, the peduncles 5 to 7 mm long. Flowers 5- or, more usually, 6-merous, about 3.5 mm long, their pedicels 2 mm long, the bracteoles narrowly ovate, acute, 1 mm long. Calyx about 2 mm in diameter, the tube short, the lobes broadly ovate to orbicular-ovate, 1 to 1.2 mm long, somewhat pubescent, the margins minutely ciliate. Corolla tube about 2 mm long, the lobes nearly as long as the tube, oblong-ovate, acute or obtuse, minutely puberulent externally, bearded at the base inside with numerous stiff hairs about 1 mm in length. Ovary ovoid, glabrous, 1 mm long; style slen-

der, glabrous, equaling the ovary. Stamens 5 or 6, the filaments inserted in the tube, the anthers oblong-ovate, 1.2 mm long, slightly apiculate and sparingly bearded at the base. Fruits globose, 1.5 cm in diameter, red when fresh, brown when dry, the pericarp rather thin, crustaceous. Seed solitary, about 1 cm in diameter, 5 mm thick, rather translucent and somewhat rugose when dry.

LUZON, Nueva Vizcaya, Uakal near Bayombong, *For. Bur. 28546 Cenabre*, June 19, 1921. In forests along river banks, altitude about 450 meters.

A species strongly characterized by its usually 6-merous flowers, short cymes, 3-plinerved, strongly shining leaves, and its small 1-seeded fruits. It is probably nearest to *S. impressinervis* A. W. Hill.

APOCYNACEAE

TABERNAEMONTANA Linnaeus

TABERNAEMONTANA MINDORENSIS sp. nov.

Frutex glaber, circiter 2 m alta, ramis ramulisque pallidis, tenuibus; foliis oblongo-lanceolatis, membranaceis, olivaceis, perspicue caudato-acuminatis, basi acutis, 5 ad 8 cm longis, nervis utrinque circiter 9, tenuibus, distinctis; cymis axillaribus, paucifloris, laxis, 1.5 ad 2 cm longis, corollae tubo 5 mm longo (alabastro) calycis lobis intus glandulosis; folliculis 2 ad 2.5 cm longis, inaequilateraliter oblongo-ovoideis, acuminatis, leviter carinatis, seminibus circiter 9.

A glabrous shrub about 2 m high, the branches and branchlets slender, terete, pale grayish. Leaves of each pair equal or more or less unequal, oblong-lanceolate, membranaceous, olivaceous, somewhat shining, 5 to 8 cm long, 1 to 2 cm wide, narrowed upward to the slenderly caudate-acuminate apex and below to the cuneate base, the lower surface paler than the upper; lateral nerves about 9 on each side of the midrib, slender, distinct, the reticulations lax, obscure; petioles 2 to 4 mm long. Cymes axillary, lax, few-flowered, 1.5 to 2 cm long. Mature flowers not seen, their pedicels about 5 to 8 mm long. Calyx lobes ovate, acute, 0.5 mm long, each with a small gland or appendage near the base inside. Corolla tube (in bud) slender, about 5 mm long, somewhat inflated in the upper part, the lobes (in bud) 2.5 mm long, inequilateral. Anthers 1.5 mm long. Follicles 2 to 2.5 cm long, red, glabrous, inequilaterally oblong-ovoid, somewhat gibbous, smooth, with 3 or 4 longitudinal ridges, these often ob-

scure, the pericarp thin, rather fragile. Seeds about 9, brown, irregular, 6 to 7 mm long.

MINDORO, Paluan, *Bur. Sci. 39577* (type), *39576 Ramos,* April 1, 1921. On forested slopes at an altitude of about 500 meters.

A species belonging in the group with *Tabernaemontana caudata* Merr., but it has larger, differently shaped leaves and different inflorescences. From *T. mindanaensis* Merr. it is distinguished by its smaller caudate-acuminate leaves and its entirely different fruits.

KOPSIA Blume

KOPSIA GRANDIFLORA sp. nov.

Frutex circiter 3 m altus, ramulis puberulis et inflorescentiis exceptis glaber; foliis chartaceis vel subcoriaceis, ellipticis ad oblongo-ellipticis, 10 ad 15 cm longis, nitidis, apice obtuse acuminatis, basi late acutis, nervis utrinque circiter 15 cum reticulis utrinque distinctis; inflorescentiis pedunculatis, depauperato-cymosis vel dichotome ramosis, paucifloris, pedunculo 3 ad 6 cm longo; bracteis orbiculari-ovatis, rotundatis, pubescentibus, 2.5 mm longis; calycis lobis elliptico-ovatis, rotundatis, 3 mm longis, pubescentibus; corollae tubo 3.7 cm longo, apice leviter incrassato, intus in partibus superioribus villoso, lobis obovatis ad elliptico-obovatis, 2.5 cm longis, 10 ad 14 mm latis, rotundatis.

A shrub about 3 m high, the younger branchlets, bracts, and calyces sparingly puberulent or pubescent. Branches glabrous, somewhat rugose when dry. Leaves chartaceous to subcoriaceous, elliptic to oblong-elliptic, 10 to 15 cm long, 4 to 6 cm wide, grayish olivaceous, shining, narrowed above to the obtusely acuminate apex and below to the broadly acute base; lateral nerves about 15 on each side of the midrib, rather prominent on both surfaces as are the primary and rather close secondary reticulations; petioles about 5 mm long. Inflorescences terminal, peduncled, the peduncles 3 to 6 cm long, the flowers in depauperate cymes or the peduncles dichotomously branched at their apices, the flowers spicately arranged on the short branches. Bracts orbicular-ovate, somewhat pubescent, about 2.5 mm long, imbricate near the apices of the branchlets, somewhat scattered below, rounded and somewhat keeled. Calyx lobes elliptic-ovate, rounded, 3 mm long, somewhat pubescent, their margins ciliate. Corolla tube cylindric, glabrous externally, somewhat villous inside in the upper part, slightly enlarged at the apex, about 3.7 cm long, the lobes white, obovate to elliptic-obovate, rounded, 2.5 cm long, 10 to 14 mm wide.

LUZON, Camarines Province, Paracale, *Bur. Sci. 33691 Ramos & Edaño,* November, 1918. In damp forests along small streams at low altitudes.

A species manifestly belonging in the group with *Kopsia fruticosa* DC. and *K. albiflora* Boerl., differing essentially from both of these in its larger flowers.

VERBENACEAE

CLERODENDRON Linnaeus

CLERODENDRON LUZONIENSE sp. nov.

Frutex erectus, glaber, ramis tenuibus; foliis membranaceis, integris, ellipticis ad oblongo-ellipticis, 13 ad 18 cm longis, olivaceis, nitidis, tenuiter acuminatis, basi cuneatis, nervis utrinque 6 vel 7, subtus perspicuis; paniculis terminalibus, glabris vel puberulis, laxis, paucifloris, ramis patulis, paucis, plerumque 3-floris, bracteis bracteolisque linearis, 4 ad 6 mm longis. Calycis 5-lobatis, lobis lanceolatis, acuminatis, 3 mm longis. Corollae tubo 5 ad 6 cm longo, lobis oblongo-ellipticis, obtusis, circiter 1 cm longis.

A glabrous, erect shrub, the branches slender, pale. Leaves membranaceous, entire, elliptic to oblong-elliptic, 13 to 18 cm long, 6 to 7 cm wide, somewhat olivaceous and shining on both surfaces when dry or the lower surface somewhat paler than the upper, not at all glandular, the apex rather slenderly acuminate, base cuneate; lateral nerves 6 or 7 on each side of the midrib, slender, rather prominent on the lower surface, the reticulations very lax; petioles 2 to 5 cm long. Panicles terminal, peduncled, glabrous or very slightly puberulent, lax, few-flowered, the peduncle and rachis up to 12 cm long, the branches few, spreading, each usually 3-flowered; bracts linear, acuminate, 4 to 6 mm long, the bracteoles similar, smaller, the pedicels 1 to 1.6 cm long. Calyx green, 5 to 7 mm long, the base cuneate, the lobes 5, lanceolate, acuminate, about 3 mm long. Corolla white, the tube slender, 5 to 6 cm long, straight, the lobes spreading, oblong-elliptic, obtuse, about 1 cm long.

LUZON, Camarines Province, Paracale, *Bur. Sci. 33784* (type), *33779 Ramos & Edaño,* December 22, 1918. In damp forests along small streams at low altitudes.

The alliance of this species is manifestly with *C. klemmei* Elm., from which it is distinguished by its differently shaped, relatively much broader leaves, longer flowers, lax, few-flowered inflorescences, and narrower calyx teeth.

CALLICARPA Linnaeus

CALLICARPA MAGNIFOLIA sp. nov.

Frutex vel arbor parva, ramulis et subtus foliis dense fulvo-tomentosis; foliis eglandulosis, oppositis, subcoriaceis, late elliptico-ovatis, 22 ad 27 cm longis, usque ad 20 cm latis, integris vel sursum obscurissime denticulatis, late acuminatis, basi rotundatis, supra glabris, olivaceis, nitidis, nervis utrinque circiter 10, valde perspicuis; cymis axillaribus, sub fructo usque ad 6 cm longis et 9 mm latis; calycibus membranaceis, 3 mm longis, breviter 4-lobatis; fructibus globosis, glabris, 3 mm diametro, disco valde accrescente, subgloboso, usque ad 1 cm diametro, densissime fulvo-tomentoso.

A shrub or small tree, the branchlets and the lower surface of the leaves densely fulvous-tomentose with rather soft, plumose and stellate hairs, the indumentum on the leaves ultimately deciduous; branches terete or somewhat compressed at the nodes, pale grayish, glabrous, about 6 mm in diameter, the branchlets reddish brown. Leaves opposite, subcoriaceous, broadly elliptic-ovate, 22 to 27 cm long, 17 to 20 cm wide, entire or very obscurely and remotely denticulate near the apex, the base broadly rounded or sometimes subacute, the apex shortly and broadly acuminate, the upper surface olivaceous, smooth, glabrous, shining, the lower surface paler, not at all glandular; lateral nerves about 10 on each side of the midrib, very prominent, the primary reticulations subparallel, distinct; petioles about 5 cm long, densely tomentose. Cymes from the axils of fallen leaves, in fruit about 6 cm long and up to 9 cm wide. Calyx membranaceous, cup-shaped, about 3 mm long, shortly 4-lobed. Fruit globose, glabrous, about 3 mm in diameter, nearly surrounded by the densely fulvous-tomentose, greatly enlarged disk, which is subglobose and up to 10 mm in diameter. Bracteoles linear, pubescent, 3 to 5 mm long.

LUZON, Kalinga Subprovince, Mount Masingit, *Bur. Sci. 37563 Ramos & Edaño,* February 17, 1920. In forests, altitude about 1,200 meters, with the local name *agnai.*

This species is remarkable for its greatly enlarged, densely fulvous-tomentose disk which surrounds and nearly incloses the fruit, a character that is unknown to me for any other described species of the genus. It is further remarkable for its unusually large leaves which are eglandular and densely tomentose on the lower surface.

VITEX Linnaeus

VITEX UNIFOLIOLATA sp. nov.

Frutex vel arbor parva, inflorescentiis parce pubescentibus exceptis glabra, ramulis quadrangulatis, 3 mm diametro; foliis unifoliolatis, coriaceis, nitidis, integris, oblongis, 20 ad 27 cm longis, subtus dense puncticulatis, acuminatis, basi rotundatis, supra plus minusve bullatis, nervis utrinque 9 ad 12, valde perspicuis; inflorescentiis solitariis, tenuibus, terminalibus, circiter 40 cm longis, ramis primariis 1 vel 2, valde elongatis, cymis paucis, distantibus, paucifloris, 3 ad 4 cm longis; calycibus cupulatis, aequaliter 5-lobatis, lobis ovatis, obtusis, 0.5 mm longis; corolla 11 mm longa, bilabiata; fructibus junioribus glabris, calycis valde accrescentibus.

A shrub or small tree, glabrous except the inflorescences, the branches pale grayish, somewhat 4-angled, the ultimate ones about 3 mm in diameter. Leaves simple, the petioles about 1 cm long, the leaflets coriaceous, pale olivaceous when dry, oblong, 20 to 27 cm long, 7 to 10 cm wide, entire, shining, the upper surface more or less bullate, the lower surface slightly paler than the upper and densely puncticulate, base rounded, apex rather slenderly acuminate; lateral nerves 9 to 12 on each side of the midrib, prominent on both surfaces, curved-anastomosing, the reticulations lax, very prominent. Inflorescences solitary, terminal, slender, about 40 cm long, the peduncle about 6 cm long, 4-angled, rather slender, about 2.5 mm in diameter, the primary branches 1 or 2 only, greatly elongated, slightly pubescent, the individual cymes widely scattered, few-flowered, 3 to 4 cm long. Flowers blue. Calyx cup-shaped, about 3 mm long, equally 5-lobed, the lobes ovate, obtuse, 0.5 mm long, appressed-pubescent with short hairs. Corolla 11 mm long, the tube 5 mm long, slightly pubescent outside; lower lip 3-lobed, the middle lobe large, orbicular, glabrous, entire, about 5 mm in diameter, the two lateral ones elliptic, rounded, 3 mm long; upper lip 2 mm long, cleft into two broadly ovate, obtuse lobes; filaments 3 to 4 mm long, somewhat exserted, villous below. Young fruit glabrous or nearly so, inclosed by the accrescent calyx.

MINDANAO, Zamboanga District, Malangas, *Bur. Sci. 37048 Ramos & Edaño,* October 27, 1919. In forests along streams at low altitudes, locally known as *babako.*

The alliance of this species is manifestly with *Vitex clarkeana* King and Gamble of the Malay Peninsula and Borneo, from which it differs in its very slender inflorescences; in details of its

corolla, the middle lobe of the lower lip being orbicular, entire, and glabrous; and in its glabrous, not tawny-pubescent fruits.

In H. Lam's recent treatment of the Verbenaceae of the Malayan Archipelago certain reductions of proposed new species must be made: *Vitex curranii* H. Lam is identical with *Vitex aherniana* Merr.; *Vitex merrillii* H. Lam is identical with *V. longifolia* Merr., which in turn is a *Teijsmanniodendron* perhaps not distinct from *T. bogoriense* Koord.; and *Vitex glandulosa* H. Lam is identical with *V. parviflora* Juss., of which *V. littoralis* Decne. is a synonym.

SCROPHULARIACEAE

LIMNOPHILA R. Brown

LIMNOPHILA OBOVATA sp. nov.

Herba subaquatica procumbens vel adscendens, leviter ramosa, caulibus usque ad 20 cm longis, glabris vel minutissime furfuraceis; foliis oppositis, obovatis vel oblongo-obovatis, acutis, breviter petiolatis, usque ad 2.5 cm longis, basi angustatis, margine serratis; floribus solitariis, axillaribus, sessilibus, calycis glabris, profunde 5-fidis, laciniis lineari-lanceolatis; corolla alba, 12 ad 13 mm longa.

A subaquatic, aromatic, procumbent or ascending plant, the stems simple or sparingly branched, 20 cm in length or less, glabrous or very minutely furfuraceous. Leaves opposite, obovate to oblong-obovate, sometimes subrhomboid, 1.5 to 2.5 cm long, 6 to 12 mm wide, acute, margins serrate, base gradually narrowed to the short petiole, the lower surface glandular-punctate. Flowers axillary, solitary, sessile, the bracts linear, 5 mm long. Calyx glabrous, the segments 5, free nearly to the base, linear-lanceolate, acuminate, about 7 mm long, 1 mm wide. Corolla white, 12 to 13 mm long. Capsule oblong-ovoid, about 3.5 mm long. Seeds very numerous, black.

PALAWAN, Ulugan Bay, *Merrill 7227* (type), September, 1910. BRITISH NORTH BORNEO, Batu Lima, near Sandakan, *Ramos 1385*, October, 1920. Along small streams in shaded places, often in shallow water, at low altitudes.

GESNERIACEAE

DICHROTRICHUM Reinwardt

DICHROTRICHUM CORIACEUM sp. nov.

Frutex scandens, glaber vel subglaber, ramulis circiter 5 mm diametro; foliis coriaceis, in paribus valde inaequimagnis dif-

formibusque, majoribus oblongis, 7 ad 11 cm longis, longe petiolatis, basi longe decurrentibus, minoribus breviter petiolatis, ovatis, obtusis, circiter 1 cm longis; infructescentiis umbellatis vel depauperato-cymosis, longe pedunculatis, calycis cupulatis, circiter 4 mm longis, lobis oblongis, truncato-obtusis, circiter 1.5 mm longis; folliculis 18 cm longis, 2 mm diametro.

A scandent, nearly glabrous shrub, the branchlets apparently somewhat fleshy, pale brownish when dry, somewhat angular, about 5 mm in diameter, sparingly appressed-pubescent. Leaves coriaceous, obscurely crenate or undulate-crenate, sometimes nearly entire, in very unequal pairs, the upper surface dull olivaceous, the lower surface pale brownish; larger leaves of each pair oblong, 7 to 11 cm long, 2.5 to 4.5 cm wide, long-petioled, acute to very shortly and obtusely acuminate, the base long-decurrent; lateral nerves about 6 on each side of the midrib, prominent, curved-ascending, the reticulations obsolete or nearly so; petioles 2 to 5 cm long; smaller leaves of each pair ovate to oblong-ovate, obtuse, entire, about 1 cm long, very shortly petioled. Infructescences long-peduncled, the peduncles about 25 cm long, the flowers umbellately arranged or depauperate-cymose at the apex, the subtending bracts oblong-elliptic to spatulate, 3 to 8 mm long. Calyx cup-shaped, about 4 mm long, slightly pubescent, the base narrowed, the lobes 5, oblong, truncate-obtuse, about 1.5 mm long; pedicels slightly pubescent, about 1.5 cm long. Follicles narrowly cylindric, about 18 cm long, 2 mm in diameter, glabrous; seeds very numerous, brown, about 1 mm long with a single hair at each end 2 to 2.5 mm in length.

MINDANAO, Bukidnon Subprovince, Mount Candoon, *Bur. Sci. 38924 Ramos & Edaño,* July 3, 1920, in the mossy forest at an altitude of about 1,600 meters.

A species allied to *Dichrotrichum glabrum* Copel., from which it is distinguished by its coriaceous and nearly entire leaves.

TRICHOSPORUM Jack

TRICHOSPORUM MINDANAENSE sp. nov. § *Holocalyx.*

Frutex scandens, leviter pilosus; foliis coriaceis, oblongis, 2.5 ad 3.5 cm longis, obtusis, basi plerumque rotundatis, junioribus leviter pilosis, vetustioribus glabris, nervis obsoletis; floribus 4 cm longis, leviter curvatis, pedunculis brevibus, 2-floris; calycis cylindraceis, 12 mm longis, leviter pilosis, lobis ovatis, obtusis, 2 mm longis; corollae tubo 2.5 cm longo, leviter piloso, lobis

ovatis, obtusis, 1 cm longis; antheris leviter exsertis; ovario glabro; folliculis 13 ad 17 cm longis, 4 mm diametro.

A scandent, apparently fleshy vine, the younger branches, inflorescences, and the leaves very sparingly pubescent or pilose. Branches usually reddish brown, glabrous, about 3 mm in diameter. Leaves coriaceous, oblong, 2.5 to 3.5 cm long, 1 to 1.5 cm wide, rather pale when dry, somewhat narrowed upward to the obtuse apex, the base usually rounded, the margins cartilaginous and somewhat recurved when dry, the midrib obscure or sometimes obsolete on the upper surface, rather prominent on the lower surface, the lateral nerves obsolete or nearly so, when young very sparingly pilose, ultimately glabrous; petioles 3 to 4 mm long, at first sparingly pilose, ultimately glabrous. Flowers red, about 4 cm long, somewhat curved, the peduncles about 5 mm long, each 2-flowered and terminal and in the uppermost axils, the pedicels 1 cm in length, somewhat pilose. Calyx 12 mm long, slightly widened upward, the lobes very broadly ovate, obtuse, about 2 mm long. Corolla tube 8 to 10 mm wide when flattened, distinctly curved, about 2.5 cm long, sparingly pubescent externally with scattered jointed hairs, the mouth oblique, the lobes ovate, obtuse, up to 1 cm long. Stamens slightly exserted, the anthers 3 mm in length. Ovary and disk glabrous, the style about 3 mm long, villous. Follicles cylindric, glabrous, 13 to 17 cm long, about 4 mm in diameter, slightly curved. Seeds verruculose, 1.5 mm long, apical hair up to 6 mm long.

MINDANAO, Bukidnon Subprovince, Mount Candoon, *Bur. Sci. 38869* (type) *38922 Ramos & Edaño*, June and July, 1920. In the mossy forest, altitude 1,100 to 1,800 meters.

A species somewhat intermediate in characters between *Trichosporum malindangense* Merr. and *T. copelandii* Merr. (*Aeschynanthus camiguinensis* Kränzl., *A. serpens* Kränzl.), its calyces being twice as long as *T. copelandii* and *T. urdanetense* Elm., but much shorter and with much shorter corollas than is the case with *T. malindangense*.

CYRTANDRA Forster

CYRTANDRA RUFOTRICHA sp. nov. § *Decurrentes*.

Suffruticosa, erecta, usque ad 35 cm alta, simplex vel e basi parce ramosa, inflorescentiis subtus foliisque perspicue rufo-ciliatis, ciliae elongatae, articulatae; foliis oppositis parum inaequalibus, oblanceolatis, chartaceis, 6 ad 12 cm longis, acutis,

deorsum angustatis, basi cuneatis, breviter petiolatis, margine crenato-dentatis, nervis utrinque 6 vel 7, perspicuis; inflorescentiis axillaribus, sessilibus vel breviter pedunculatis, plerumque 3-floris, floribus sessilibus, dense rufo-ciliatis, bracteis binis oblongo-ellipticis ad ovatis ciliatis 10 ad 12 mm longis deciduis instructis; calycis dense ciliatis, 9 ad 11 mm longis, lobis lanceolatis, caudato-acuminatis, tubo subaequantibus; ovario glabro; fructibus oblongo-cylindraceis, usque ad 11 mm longis, glabris.

An erect, suffrutescent, usually unbranched plant, or sparingly branched from the base, up to 35 cm high, the stems 2 to 3 mm in diameter, straw-colored, glabrous except at and below the nodes where they are conspicuously ciliate with castaneous, elongated, jointed hairs. Leaves opposite, those of each pair subsimilar in shape, but one usually about one-half as large as the other, chartaceous, oblanceolate to oblong-oblanceolate, 6 to 12 cm long, 2 to 3.5 cm wide, acute, narrowed below, base cuneate, margins crenate-dentate and usually conspicuously ciliate, the upper surface olivaceous, the lower pale, both surfaces conspicuously ciliate with dark-brown, spreading, elongated, jointed, rather stiff hairs, these widely scattered on the upper surface, mostly on the midrib, nerves, and reticulations beneath; lateral nerves 6 or 7 on each side of the midrib, prominent as are the lax reticulations; petioles ciliate, 5 to 12 mm long. Inflorescences axillary, the flowers few, umbellate or fascicled, the peduncles up to 4 mm long, ciliate, or wanting, the two bracts subtending the flowers oblong-elliptic to ovate, ciliate on both surfaces, 10 to 12 mm long, 5 to 10 mm wide, sessile, deciduous. Flowers sessile, usually three in each inflorescence. Calyx densely ciliate, the tube 5 to 6 mm long, the lobes lanceolate, caudate-acuminate, 4 to 5 mm long. Corolla densely ciliate. Disk glabrous, crenulate, 1 mm high. Ovary and style glabrous. Fruit oblong-cylindric, glabrous, 8 to 12 mm long, 5 mm in diameter.

MINDANAO, Zamboanga District, Mount Tubuan, *Bur. Sci. 36655* (type), *36689 Ramos & Edaño,* October, 1919. In forests along streams at low altitudes.

A species strongly characterized by its indumentum, the rather stiff, jointed hairs up to 3.5 mm in length being brown to castaneous in color, occurring on the stems near and below the nodes, both surfaces of the leaves, and on the petioles, bracts, calyces, and corollas. It does not appear to be closely allied to any previously described form.

CYRTANDRA ACLADA sp. nov. § *Decurrentes.*

Frutex erectus, simplex, usque ad 1 m altus; foliis oppositis, aequalibus, chartaceis vel subcoriaceis, oblongis, usque ad 20 cm longis, petiolatis, supra olivaceis, glabris, subtus pallidis, ad costa nervisque leviter pubescentibus, basi acutis, apice breviter acuminatis, margine sursum obscure crenulato-denticulatis, nervis utrinque 7 vel 8, persipicuis; inflorescentiis caulinis, basifloris, brevissime pedunculatis, floribus paucis, subumbellatim dispositis vel fasciculatis, 4.5 cm longis, extus villosis.

An erect unbranched shrub up to 1 m high, the younger parts obscurely pubescent. Stems glabrous, pale brownish or grayish, up to 7 mm in diameter, the lower part leafless. Leaves opposite, those of each pair equal or subequal, chartaceous to subcoriaceous, 15 to 20 cm long, 5 to 7 cm wide, the apex distinctly acuminate, base equilateral, cuneate, the margins in the upper part obscurely crenulate-denticulate, the upper surface dark-olivaceous, glabrous, the lower surface pale and obscurely pubescent on the midrib and nerves; lateral nerves 7 or 8 on each side of the midrib, rather prominent, the reticulations slender, lax; petioles 2.5 to 4 cm long, glabrous or nearly so. Inflorescences cauline, at the very base of the stem, sometimes from the roots, shortly peduncled, subumbellate, rather few-flowered or the umbels sometimes reduced to sessile fascicles. Flowers few, 4.5 cm long, their pedicels up to 1 cm long, the bracts few, 10 to 12 mm long, membranaceous, deciduous, linear-lanceolate. Calyx about 24 mm long, more or less pubescent, slender, cylindric, the lobes lanceolate, caudate-acuminate, 6 to 8 mm long. Corolla white, sparingly pilose externally with long weak hairs, the lower 2 cm narrow, then widened. Filaments 6 mm long, glabrous; anthers 2 mm long. Disk cylindric, glabrous, 2.5 mm long, somewhat crenate. Ovary lanceolate, glabrous, about 1 cm long; style pubescent in the upper two-thirds, about 14 mm long; stigma oblique. Fruits cylindric, glabrous, 2 to 2.5 cm long, 5 mm in diameter.

MINDANAO, Zamboanga District, Malangas and Mount Tubuan, *Bur. Sci. 36616* (type), *36907 Ramos & Edaño,* October, 1919. On damp forested slopes at low and medium altitudes.

A species belonging in the group with *Cyrtandra radiciflora* C. B. Clarke, but with different inflorescences, larger flowers, much longer calyces, glabrous ovaries, etc. Among the Philippine species it is apparently most closely allied to *Cyrtandra tecomiflora* Kränzl., but has very different vegetative characters.

CYRTANDRA BARNESII sp. nov. § *Dissimiles.*

Frutex erectus, 1 ad 3 m altus, perspicue ciliatus; foliis oppositis, in paribus valde inaequalibus, majoribus petiolatis, oblongo-oblanceolatis ad oblongo-obovatis, 15 ad 22 cm longis, acuminatis, basi cuneatis, nervis utrinque circiter 8, minoribus sessilibus, ovatis, 2 ad 5 cm longis, perspicue lateque cordatis; floribus 4 cm longis, paucis, fasciculatis vel depauperato-umbellatis; bracteis 2 vel 3, elliptico-ovatis, 5 ad 8 mm longis; calycis pilosis, 15 ad 20 mm longis, lobis lanceolatis, caudato-acuminatis, 10 ad 12 mm longis; corolla pilosa, tubo deorsum angustato; ovario dense ferrugineo-piloso.

An erect shrub 1 to 3 m high, the branchlets, younger leaves, and inflorescences rather conspicuously ciliate with elongated, weak, jointed hairs, the older branches glabrous or nearly so. Leaves opposite, those of each pair very unequal in shape and size, the larger ones oblong-oblanceolate to oblong-obovate, 15 to 22 cm long, 5 to 7 cm wide, rather prominently acuminate, narrowed below to the cuneate and usually distinctly inequilateral base, the margins rather coarsely toothed; lateral nerves about 8 on each side of the midrib, prominent on the lower surface, the reticulations distinct, lax; petioles 1.5 to 2 cm long; smaller leaves of each pair sessile or subsessile, ovate, 2 to 5 cm long, 1.5 to 3 cm wide, deeply cordate, scarcely acuminate, rather coarsely toothed. Both types of leaves are chartaceous, olivaceous on the upper surface, paler beneath and supplied on both surfaces with few to many, weak, spreading, jointed hairs. Inflorescences axillary, the flowers white, about 4 cm long, fascicled or in very greatly reduced, usually 2- or 3-flowered, short-peduncled umbels, the peduncles when present about 5 mm long and supplied with a whorl of 2 or 3 ovate to elliptic-ovate, somewhat pilose bracts 5 to 8 mm in length, the pedicels pilose, up to 1 cm in length or somewhat longer in fruit. Calyx 15 to 20 mm long, supplied with numerous, weak, jointed hairs, the tube broad, 5 to 8 mm long, the lobes lanceolate, caudate-acuminate, 10 to 12 mm long. Corolla tube rather narrowed below, widened above, sparingly pilose externally. Filaments 12 mm long, glabrous, the anthers ellipsoid, 3 mm long, connate throughout; staminodes slender, glabrous, 5 to 6 mm long. Disk cylindric or cup-shaped, glabrous, 2 mm long, shallowly lobed or crenate. Ovary oblong, densely subferruginous-pilose; styles about 11 mm long, pilose, somewhat thickened in the upper 4 mm and supplied with capitate-glandular hairs; stigma about 3 mm wide, 2 mm long, elliptic

in outline. Fruits oblong-ovoid, about 1 cm long, densely ferruginous-pilose.

LUZON, Benguet Province, Mount Tonglon, *For. Bur. 920 Barnes* (type), May, 1904, *Merrill 7801*, May, 1911. In very damp shaded ravines in the mossy forest, altitude about 2,000 meters. A form of the same species is represented by *Bur. Sci. 37541, 37800 Ramos & Edaño* from Bontoc and Kalinga Subprovinces, Luzon, February and March, 1920, these specimens differing from the type in being more densely pilose and in some of the larger leaves being obtuse or even obliquely cordate at the base.

This species has been confused with *Cyrtandra lobbii* C. B. Clarke, from which it differs radically in its very dissimilar leaves, the smaller one of the pair being sessile, ovate, deeply cordate and entirely different in shape and size from the larger one of each pair.

CYRTANDRA ZAMBOANGENSIS sp. nov. § *Dissimiles*.

Species C. auriculatae affinis, differt foliis omnibus petiolatis, crenatis, haud lobatis, paribus leviter inaequalibus, floribus multo minoribus, ovarium glabrum.

A slender, prostrate, conspicuously ciliate herb, the main stems up to 30 cm in length, rooting at their nodes, and with short ascending branches, the stems, branches, and branchlets densely ciliate with rather weak, jointed hairs. Leaves opposite, those of each pair unequal, all petioled, the larger one of each pair usually about twice as large as the smaller one but similar in shape, the larger ones elliptic, up to 4 cm long and 2.2 cm wide, the smaller ones up to 2 cm long and 1.5 cm wide, all membranaceous to chartaceous, olivaceous, obtuse or rounded, acute to rounded at the base, somewhat crenate, both surfaces supplied with numerous, long, weak, jointed hairs, these hairs 3 to 5 mm in length, pale; lateral nerves 4 or 5 on each side of the midrib, not prominent; petioles densely villous, 5 to 15 mm long. Flowers white, about 14 mm long, terminal or in the upper axils, the peduncles 1 to 2 mm long, pilose, 2-flowered, 2-bracteate, the bracts oblong, 3 mm long, somewhat pilose, the pedicels 1 to 1.5 mm in length. Calyx 6 mm long, pilose, the lobes 5, lanceolate, caudate-acuminate, as long as the tube. Corolla tube sparingly pilose in the lower half, the tube slender in the lower 5 to 6 mm, then widened, the lobes ovate, 3 to 3.5 mm long. Filaments 2.5 mm long, glabrous, the anthers 1 mm in length. Disk cup-shaped, glabrous, 1 mm high, crenulate. Ovary oblong-ovoid,

glabrous; style 7 mm long, somewhat pilose in the upper third. Fruits ovoid, 4 to 5 mm long.

MINDANAO, Zamboanga District, Malangas and Mount Tubuan, *Bur. Sci. 37249* (type), *36685 Ramos & Edaño*, October and November, 1919. On forested slopes at low altitudes.

A species with the habit and much the general appearance of *Cyrtandra auriculata* C. B. Clarke, differing radically in its much smaller flowers and in its crenate not lobed leaves which are all petioled and similar in shape, the smaller one of each pair being usually about one-half as large as the larger one.

CYRTANDRA PARVA sp. nov. § *Dissimiles.*

Planta parva, suffruticosa, caulis prostratis, radicantibus, 1.5 mm diametro, ramis brevibus, erectis; foliis oppositis, petiolatis, inferioribus in paribus valde inaequalibus, superioribus subaequalibus, majoribus oblongo-obovatis ad oblongo-ellipticis, 5 ad 8 cm longis, apice plerumque acutis, basi cuneatis, margine serratis, subtus pallidis, ad costa et nervis et reticulis perspicue ciliatis, nervis utrinque 6 vel 7; foliis minoribus 1 ad 1.5 cm longis, 5 ad 8 mm latis; floribus paucis, depauperato-umbellatis, 2.5 cm longis, umbellis plerumque 3-floris, pedunculis pedicellisque brevibus, hirsutis; bracteis lanceolatis, 6 ad 7 mm longis; calycis 1.5 cm longis, ciliato-hirsutis, lobis lanceolatis, caudato-acuminatis, tubo aequantibus, corolla extus leviter pilosa, 2.5 cm longa; ovario glabro.

A slender, prostrate, suffrutescent plant with short ascending branches, the stems copiously rooting, the older ones glabrous, about 1.5 mm in diameter, the younger parts and the leaves on the midrib, nerves and reticulations beneath conspicuously ciliate with slender, elongated, brown hairs. Leaves opposite, those of the lower pairs very dissimilar in shape and size, those of the uppermost pairs often subequal, all olivaceous, glabrous on the upper surface, paler beneath, membranaceous or chartaceous, the larger ones oblong-obovate to oblong-elliptic, 5 to 8 cm long, 2 to 3 cm wide, the apex usually acute, base usually cuneate, the margins rather sharply serrate, often conspicuously ciliate; lateral nerves 6 or 7 on each side of the midrib, prominent on the lower surface as are the primary reticulations; petioles about 2 cm long; smaller leaves of each pair, at least in the lower part of the stem, similar in shape and texture to the larger ones, 1 to 1.5 cm long, 5 to 8 mm wide. Inflorescences terminal or in the upper axils, their peduncles about 5 mm long, hirsute, each peduncle usually bearing 3 subumbellately arranged flowers,

the pedicels hirsute, about 4 mm long. Bracts lanceolate, acuminate, membranaceous, 6 to 7 mm long. Flowers about 2.5 cm long. Calyx 1.5 cm long, rather conspicuously ciliate-hirsute, the spreading hairs 1.5 to 2.5 mm long, the tube 7 to 8 mm long, the lobes narrowly lanceolate, slenderly caudate-acuminate, ciliate-hirsute, equaling the tube in length. Corolla tube about 1.8 cm long, narrow in the lower portion, gradually widened upward, somewhat pilose. Filaments glabrous, 3 to 4 mm long; anthers connate, 1.5 mm long. Disk 0 or very obscure. Ovary glabrous, lanceolate, the style appressed-hirsute, 6 to 7 mm long.

MINDANAO, Zamboanga District, Malangas, *Bur. Sci. 36833* (type), *37248 Ramos & Edaño,* November, 1919. Along streams in forests at low altitudes.

A species well characterized by its small size, the prostrate slender stems copiously rooting, the leafy branches short, erect, as well as by its rather conspicuous, brown, ciliate indumentum and its dissimilar leaves, those of the lower pairs very different in size, those of the uppermost pairs being equal or subequal.

CYRTANDRA SUBGLABRA sp. nov.

Frutex erectus, usque ad 1 m altus, simplex, floribus exceptis glaber, caulis 5 mm diametro; foliis oppositis, in paribus subaequalibus, membranaceis, oblongis ad oblongo-ovatis, longe petiolatis, 14 ad 28 cm longis, acuminatis, basi cuneatis, margine integris; inflorescentiis axillaribus, 2- vel 3-floris, sessilibus vel brevissime pedunculatis, bracteis binis foliaceis persistentibus 18 mm longis, ellipticis vel elliptico-ovatis instructis; floribus sessilibus, 4.5 ad 5 cm longis, calycis 12 mm longis, lobis oblongo-ovatis, 3 mm longis, glabris; corolla pilosa, tubo deorsum angustato; ovario glabro, stylis leviter pilosis.

An erect, unbranched shrub up to 1 m high, entirely glabrous except the conspicuously pilose corollas, the stems pale when dry, about 5 mm in diameter. Leaves opposite, those of each pair equal or subequal in size and shape, membranaceous, subolivaceous, oblong to oblong-ovate, 14 to 28 cm long, 5 to 8 cm wide, narrowed above to the rather conspicuously acuminate apex and below to the cuneate and often slightly inequilateral base, the margins entire; lateral nerves 7 to 9 on each side of the midrib, prominent on the lower surface, the reticulations rather lax, slender; petioles 3 to 8 cm long. Inflorescences axillary, solitary, 2- or 3-flowered, the peduncles 2 to 3 mm long, each peduncle supplied with two, persistent, subfoliaceous bracts, the bracts elliptic to elliptic-ovate, sessile, about 18 mm long, 21 mm wide, compli-

cate, somewhat acuminate, persistent and somewhat accrescent in fruit, attaining a length of 2.5 cm, longitudinally 7-nerved, somewhat reticulate. Flowers sessile, white, 4.5 to 5 cm long, calyx about 12 mm long, at first 2-lobed, ultimately equally 5-lobed, the lobes oblong-ovate, acute or acuminate, 3 mm long. Corolla tube conspicuously pilose externally with long, weak hairs, the lower 18 mm narrow, cylindric, then widened. Filaments 12 mm long, glabrous, the anthers 2 mm in length, connate. Staminodes filiform, glabrous, 5 to 6 mm long. Disk cylindric, glabrous, nearly 3 mm long, slightly crenulate. Ovary glabrous, the styles slightly pilose, the stigma oblique, 1 mm long, 3 mm wide. Fruit oblong, subcylindric, glabrous, 1.5 to 2 cm long.

MINDANAO, Zamboanga District, Malangas, *Bur. Sci. 36937* (type), *36742 Ramos & Edaño,* October and November, 1919. Along streams in damp forests at low altitudes.

A species strongly characterized by its unbranched habit; by its opposite, subequal, long-petioled, entire leaves; and especially by its peculiar inflorescences which are axillary, short-peduncled, supplied with two conspicuous, persistent bracts subtending the usually three sessile flowers. The species is entirely glabrous except the conspicuously pilose corollas. It does not appear to be closely allied to any previously described species of the genus and is aberrant in the various sections of the genus as defined by C. B. Clarke, although apparently coming nearest to the section *Coccineae.*

ACANTHACEAE

HYPOESTES R. Brown

HYPOESTES MINDORENSIS sp. nov.

Planta erecta, suffruticosa, ramosa, circiter 1 m alta, ramulis puberulis; foliis ovatis, membranaceis, 6 ad 9 cm longis, utrinque plus minusve puberulis, sursum angustatis, apice tenuiter acute acuminatis, basi late subtruncato-rotundatis, nervis utrinque circiter 8; inflorescentiis puberulis, floribus subdistiche dispositis, bracteis 15 mm longis, lanceolatis, caudato-acuminatis, sursum distincte ciliatis, deorsum (4 mm) connatis, bracteis interioribus circiter 10 mm longis, acuminatis; bracteolis 1 mm longis; calycis lobis membranaceis, 2 mm longis, lanceolatis; corollae tubo 7 mm longo, lobis 11 ad 13 mm longis, angustioribus 1 mm latis, latioribus oblongo-obovatis, 5 mm latis.

An erect, branched, suffrutescent or distinctly woody plant about 1 m high, the branches glabrous, the branchlets more or

less puberulent. Leaves ovate, membranaceous, 6 to 9 cm long, 3.5 to 5 cm wide, both surfaces more or less puberulent, at least along the midrib and lateral nerves, the upper surface dark olivaceous, the lower pale, gradually narrowed upward to the slenderly and sharply acuminate apex, the base broadly rounded, often truncate; lateral nerves about 8 on each side of the midrib, prominent on the lower surface, the reticulations distinct; petioles 1.5 to 3 cm long. Inflorescences axillary and subterminal, the lower ones often with peduncles up to 4 cm in length, the upper ones short-peduncled, the flowers distichously arranged on the branchlets, the peduncles, rachis, branches, and bracts puberulent. Flowers about 2 cm long, pale purplish, the connate bracts about 15 mm long, lanceolate, slenderly caudate-acuminate, distinctly ciliate in the upper one-half with spreading, weak, crisped hairs, united for the lower 4 to 5 mm, the inner two or three bracts lanceolate, acuminate, somewhat pubescent, 9 to 10 mm long, about 2 mm wide, narrowed at both ends, the bracteoles lanceolate, acuminate, 1 mm long. Calyx about 6 mm long, somewhat pubescent, the lobes 5, membranaceous, lanceolate, acuminate, 2 mm long. Corolla tube about 7 mm long, glabrous below, somewhat pubescent above, the narrower lobe 11 to 12 mm long, about 1 mm wide, the broader one 12 to 13 mm long, 5 mm wide, oblong-obovate, slightly narrowed below, the apical lobules 1.5 to 2 mm long, the middle one somewhat broader than the two lateral ones. Filaments slightly pubescent; anthers oblong, about 2.5 mm long.

MINDORO, Paluan, *Bur. Sci. 39702 Ramos*, April, 1921. In dry forests at low altitudes.

This species somewhat resembles *Hypoestes cinerea* C. B. Clarke, but differs totally in its caudate-acuminate leaves and involucral bracts. In its floral and inflorescence characters it is manifestly allied to *H. subcapitata* C. B. Clarke and *H. laxiflora* Nees, but differs radically from both of these in its vegetative characters.

HYPOESTES AXILLARIS sp. nov.

Suffruticosa, erecta, ramosa, usque ad 50 cm alta, leviter pubescentibus; foliis in paribus subaequalibus vel inaequalibus, ovatis ad oblongo-ovatis, majoribus 6 ad 12 cm longis, minoribus 3 ad 6 cm longis, acute acuminatis, basi acutis, membranaceis, olivaceis, nervis utrinque 6 vel 7; inflorescentiis axillaribus terminalibusque, involucris paucis, solitariis vel fasciculatis, sessilibus vel pedunculatis; bracteis 4, lanceolatis, acuminatis,

11 mm longis, cinereo-pubescentibus; floribus circiter 18 mm longis.

An erect, suffrutescent, branched plant, up to 50 cm high, more or less cinereous-pubescent. Leaves in equal or distinctly unequal pairs, ovate to oblong-ovate, acutely acuminate, base acute, membranaceous, olivaceous, the larger ones 6 to 12 cm long and 4 to 6 cm wide, the smaller ones 3 to 6 cm long and 2 to 3 cm wide, the upper surface rather minutely cinereous-pubescent with scattered hairs, the indumentum more conspicuous on the midrib, the lower surface somewhat pubescent, paler; lateral nerves 6 or 7 on each side of the midrib, slender, distinct; petioles cinereous-pubescent, 1 to 4 cm long. Flowers pink, chiefly axillary, the involucres few, solitary or fascicled, never more than 5 in a fascicle, sessile or shortly peduncled; bracts 4, lanceolate, slenderly acuminate, about 11 mm long, sparingly cinereous-pubescent, the outer two united for the lower 3 mm. Calyx 5 to 6 mm long, pubescent, membranaceous, the lobes lanceolate, acuminate, 2 mm in length. Corolla 1.8 cm long, sparingly hirsute externally in the upper two-thirds, the tube 9 mm long, glabrous below, the lower lip 9 mm long, 3-lobed, the lobes broadly ovate, rounded, 2 mm in length. Filaments 7 mm long, slightly ciliate; anthers 1.5 mm long.

MINDANAO, Zamboanga District, near Zamboanga, *Merrill 5473* (type), October, 1906, *For. Bur. 9231 Whitford & Hutchinson,* January, 1908, *Bur. Sci. 16384, 16503 Reillo,* October, 1912. In shaded ravines at low altitudes.

Among the Philippine species perhaps as close to *Hypoestes subcapitata* C. B. Clarke as any, but remote from it in its vegetative, inflorescence, and bract characters, the bracts being merely pubescent, not at all ciliate. A striking character of the present species is its chiefly axillary inflorescences, the involucres being fascicled, not arranged on an elongated rachis, and often solitary or in pairs, or never exceeding five in a single inflorescence.

HYPOESTES TENUIS sp. nov.

Herba parva, ramosa, circiter 20 cm alta, erecta vel deorsum decumbens, caulis vix 1 mm diametro; foliis in paribus aequalibus, ovatis ad oblongo-ovatis, membranaceis, 1 ad 3 cm longis, obtusis vel obtuse acuminatis, nervis utrinque 3 vel 4; inflorescentiis axillaribus terminalibusque, involucris paucis, plerumque spicatim dispositis, spicis usque ad 5 cm longis; bracteis 4, lanceolatis, acuminatis, 8 ad 9 mm longis, minute cinereo-pubescentibus; floribus 1.5 cm longis.

A slender, branched, erect herb, up to 20 cm high, the stems 1 mm or less in diameter, terete, often decumbent below, the branches, petioles, and inflorescences minutely cinereous-pubescent. Leaves in equal pairs, ovate to oblong-ovate, membranaceous, 1 to 3 cm long, 7 to 14 mm wide, obtuse or sometimes broadly and obtusely acuminate, the base acute, the upper surface olivaceous, sparingly pubescent with short, scattered hairs, the lower surface paler, minutely pubescent at least on the midrib and nerves; lateral nerves usually 3 or 4 on each side of the midrib, slender; petioles 2 to 6 mm long, minutely pubescent. Involucres for the most part spicately arranged, the spikes terminating the branchlets, a few solitary ones in the upper axils, the spikes up to 5 cm long, presenting at most 5 or 6 involucres. Bracts 4, lanceolate, acuminate, 8 to 9 mm long, minutely cinereous-pubescent, the outer two united for the lower 2 to 3 mm. Calyx 2 to 3 mm long, membranaceous, the lobes narrowly lanceolate, acuminate, somewhat ciliate, nearly as long as the tube. Corolla 1.5 cm long, sparingly hirsute in the upper part, the tube 7 mm long, glabrous; upper lip 8 mm long, 2 mm wide, narrowly oblong, 2-nerved, obtuse; lower lip as long as the upper one, 5 mm wide, somewhat narrowed below, 3-lobed, the lobes about 2 mm long, ovate, rounded. Filaments 5 mm long; anthers about 1 mm long.

LUZON, Cagayan Province, between Mision and San Vicente, *For. Bur. 16693 Bacani,* March, 1909, near the seashore.

A species strongly characterized by its small size, its slender stems, small leaves, and spicately arranged flowers.

HYPOESTES CONFERTIFLORA sp. nov.

Erecta, usque ad 60 cm alta, inflorescentiis perspicue ciliatis exceptis glabra; foliis in paribus subaequalibus, chartaceis, oblongis, 6 ad 17 cm longis, acuminatis, basi decurrentibus, nervis utrinque circiter 9; inflorescentiis terminalibus, subcapitatis, confertis, 2 cm diametro, multifloris; involucris numerosis, bracteis 4, lanceolatis, acuminatis, exterioribus 12 ad 13 mm longis, dense longeque albido-ciliatis, interioribus leviter ciliatis; calycis 8 mm longis, pubescentibus, lobis lineari-lanceolatis, tubo aequantibus.

An erect, somewhat branched, herbaceous or suffrutescent plant, up to 60 cm high, entirely glabrous except the very prominently ciliate inflorescences. Stems terete, smooth, straw-colored, about 4 mm in diameter, the internodes 6 to 16 cm long. Leaves in equal or subequal pairs, chartaceous, oblong, 6 to 17

cm long, 3 to 5 cm wide, pale brownish when dry, subequally narrowed to the somewhat acuminate apex and the decurrent base; lateral nerves about 9 on each side of the midrib, rather prominent on the lower surface, the reticulation obscure; petioles 1 to 2.5 cm long. Flowers crowded in a dense, subglobose, sessile or very shortly peduncled, terminal inflorescence about 2 cm in diameter. Involucral bracts 4 subtending each flower, the outer two lanceolate, acuminate, 12 to 13 mm long, very densely ciliate in the upper two-thirds with white, 2 mm long, spreading hairs, the lower third glabrous or only slightly pubescent, the inner two bracts similar to the outer ones but shorter and ciliate only on the median portion of the back. Calyx pubescent, 8 mm long, the lobes linear-lanceolate, acuminate, equaling the tube.

LUZON, Zambales Province, Santa Maria, *Bur. Sci. 4756 Ramos*, December, 1907. In open places at low altitudes.

A species very strongly characterized by its dense, subcapitate inflorescences, and more especially by its densely and very conspicuously ciliate involucral bracts. Its alliance is with *Hypoestes subcapitata* C. B. Clarke, from which it is readily distinguished by its larger, more numerously nerved leaves, its inflorescence and involucre characters, and by being glabrous throughout except for the inflorescences.

HEMIGRAPHIS Nees

HEMIGRAPHIS LANCEOLATA sp. nov.

Herba erecta, ramosa, 50 ad 70 cm alta, partibus junioribus perspicue hirsutis; foliis lanceolatis, chartaceis, in siccitate fragilis, 6 ad 14 cm longis, caudato-acuminatis, basi acutis, margine undulato-crenatis, glabris, nervis utrinque 4 ad 8; spicis terminalibus axillaribusque, usque ad 7 cm longis, bracteis foliaceis, numerosis, lanceolatis, 1.5 ad 2 cm longis, utrinque hirsutis, acuminatis, basi acutis; calycis segmentis lineari-lanceolatis, caudato-acuminatis, hirsutis, 10 mm longis; corolla alba, 1.6 cm longa, sursum pubescens, lobis 4 mm longis; filamentis longioribus villosis, brevioribus glabris; capsulis hirsutis, 6 ad 7 mm longis.

An erect, branched herb, 50 to 70 cm high, the younger parts rather conspicuously hirsute with stiff, white hairs, the stems and branches dark-colored when dry, glabrous or very slightly pubescent, usually sulcate. Leaves lanceolate, chartaceous, brittle when dry, 6 to 14 cm long, 1 to 3 cm wide, olivaceous,

narrowed upward to the slenderly caudate-acuminate apex and below to the acute base, the upper surface glabrous, smooth, with numerous irregularly arranged cystoliths, the lower surface uniformly dark purple when fresh, when dry nearly the same color as the upper surface, glabrous or when young sparingly hirsute, the margins irregularly undulate-crenate; lateral nerves 4 to 8 on each side of the midrib, distant, anastomosing; petioles 1 to 2 cm long. Spikes terminal and in the uppermost axils forming a somewhat leafy inflorescence, the individual inflorescences 7 cm long or less; bracts foliaceous, lanceolate, 1.5 to 2 cm long, about 5 mm wide, hirsute on both surfaces with scattered, stiff, spreading, white hairs, narrowed below to the acute base and above to the acuminate or acute apex, the internodes of the inflorescences up to 1 cm in length. Calyx segments linear-lanceolate, caudate-acuminate, about 10 mm long, 1 mm wide, hirsute. Corolla white, about 1.6 cm long, the tube slender, cylindric and glabrous in the lower 5 mm, then broadened and sparingly pubescent externally, the lobes elliptic, rounded, about 4 mm long, the tube somewhat villous inside in the upper part. Longer filaments 3 mm in length, villous, the shorter ones glabrous; anthers 1.2 mm long. Ovary villous in the upper half; style glabrous. Capsules oblong, hirsute, 6 to 7 mm long, about 1.8 mm wide.

NEGROS, Cadiz, *Bur. Sci. 7330 Celestino*, March, 1909. BALUT, *Merrill 5413* (type), October, 1906. On open, steep slopes in semicultivated ground at low altitudes, ascending to 500 meters.

A species strongly characterized by its narrow, lanceolate, caudate-acuminate leaves which are green on the upper surface and uniformly dark purple on the lower surface when fresh, as well as by its numerous, foliaceous, lanceolate, hirsute bracts. The specimens were originally referred to *Hemigraphis hirsuta* T. Anders.

HEMIGRAPHIS PACHYPHYLLA sp. nov.

Herba erecta, ramosa, leviter hirsuta, usque ad 60 cm alta; foliis in paribus aequalibus vel subaequalibus, coriaceis, olivaceis, in siccitate fragilis, ellipticis ad oblongis, 6 ad 11 cm longis, basi acutis, apice acutis vel leviter acuminatis, supra glabris, subtus scaberulis, nervis utrinque 5 vel 6; inflorescentiis terminalibus, spicatis, spicis plerumque 3, pedunculatis, usque ad 5 cm longis; bracteis numerosis, foliaceis, oblongis ad lanceolatis, utrinque angustatis, 12 ad 14 mm longis, hirsutis; calycis lobis

hirsutis, lineari-lanceolatis, circiter 7 mm longis; corolla alba, 1.8 cm longa, extus leviter pubescens; filamentis longioribus perspicue villosis; capsulis 11 mm longis, oblongis, cinereo-pubescentibus.

An erect, branched, somewhat hirsute herb, up to 60 cm high, the older stems glabrous, terete or somewhat 4-angled, the younger branches sparingly hirsute with short, usually appressed hairs. Leaves in equal or subequal pairs, coriaceous, olivaceous, brittle when dry, elliptic to oblong, 6 to 11 cm long, 2 to 4 cm wide, subequally narrowed to the acute base and the acute or somewhat acuminate apex, the upper surface glabrous, smooth, and with numerous, irregularly arranged cystoliths, the lower surface scabrid and more or less pubescent on the midrib and nerves, the margins irregularly crenate; lateral nerves 5 or 6 on each side of the midrib, rather prominent, anastomosing, the primary reticulations lax; petioles more or less pubescent, 1 to 2 cm long. Inflorescences terminal, usually consisting of 3 peduncled spikes from the tip of each branch, the peduncles up to 1.5 cm long, the spikes up to 5 cm in length. Bracts coriaceous, oblong to lanceolate, narrowed upward to the obtuse apex and below to the acute base, 12 to 14 mm long, 4 to 5 mm wide, sparingly hirsute with stiff, short hairs on both surfaces. Calyx about 7 mm long, somewhat hirsute, the lobes linear-lanceolate, slender, acuminate, nearly free, the tips of the lobes supplied with 1 to 3 very slender hairs up to 2 mm in length. Corolla white, about 1.8 cm long, the tube glabrous in the lower, slender 6 mm, then gradually widened and sparingly pubescent, the lobes broadly ovate, 3 to 4 mm long. Longer filaments 2 mm in length, densely villous on one side, the shorter ones very sparingly villous; anthers 2 mm long. Ovary oblong, 2 to 5 mm long, densely pubescent; style somewhat villous. Capsules about 11 mm long, cinereous-pubescent, oblong, somewhat acuminate; seeds ovoid, 1.3 mm long, minutely pubescent.

LUZON, Camarines Province, Paracale, *Bur. Sci. 33974* (type), *33647 Ramos & Edaño,* December, 1918. In thickets and in recent clearings at low altitudes. *Bur. Sci. 33477 Ramos & Edaño* from the same locality differs in its relatively somewhat broader, longer-petioled leaves, but probably represents the same species.

A species in the general alliance with *Hemigraphis cumingiana* F.-Vill., from which it is distinguished among other characters by its much thicker leaves which are scabrid on the lower surface.

PERISTROPHE Nees

PERISTROPHE CORDATIBRACTEA sp. nov.

Herba annua, 30 ad 40 cm alta, ramosa, ramulis junioribus leviter pubescentibus; foliis lanceolatis, chartaceis, utrinque cystolithis numerosis instructis, 3 ad 7 cm longis, sursum angustatis, apice obtuse acuminatis, basi acutis ad subobtusis, nervis utrinque 4 vel 5; cymis paucifloris, bracteis inferioribus oblongis ad lanceolatis, 2 ad 3 mm longis, superioribus foliaceis, ovatis ad oblongo-ovatis, acutis, basi late rotundatis et distincte cordatis, 12 ad 15 mm longis, 6 ad 10 mm latis; floribus circiter 2.2 cm longis, sepalis anguste lanceolatis, 4 mm longis, corolla sursum leviter ciliata; capsulis 10 mm longis, leviter hirsutis, seminibus 8.

A slender annual herb 30 to 40 cm high, the lower portions of the stems often decumbent, the branches, leaves, and bracts with numerous cystoliths, the branches at most 1.5 mm in diameter, the very young branchlets sparingly appressed-pubescent. Leaves lanceolate, chartaceous, 3 to 7 cm long, 7 to 15 mm wide, dark olivaceous when dry, entire or very obscurely undulate, narrowed upward to the blunt-acuminate apex, the base acute to subobtuse; lateral nerves 4 or 5 on each side of the midrib, slender, obscure; petioles 3 to 10 mm long. Cymes terminal, few-flowered, the bracts subtending the pedicels narrow, oblong to lanceolate, at most 2 to 3 mm long, the two foliaceous bracts subtending the flowers ovate to oblong-ovate, acute, the base broadly rounded and distinctly cordate, 12 to 15 mm long, 6 to 10 mm wide, sessile, the bracteoles narrowly lanceolate, acuminate, 4 to 6 mm long. Sepals narrowly lanceolate, acuminate, slightly pubescent, 4 mm long. Corolla pale purplish, about 2.2 cm long, the tube slender, 12 mm long and slightly ciliate above, the broader lobes 9 to 10 mm long, 6 to 7 mm wide, obovate, the narrower one oblong, obtuse, about 4 mm wide. Anthers linear-oblong, 3.5 to 4 mm long, the upper cell slightly overlapping the upper portion of the lower one. Capsules about 10 mm long, sparingly hirsute, the basal narrowed portion 5 mm long, the seed-bearing part oblong, somewhat acuminate, about 2 mm in diameter. Seeds 8, about 2 mm in diameter.

MINDORO, Mount Calavite, *Bur. Sci. 39392 Ramos*, April, 1921. Along streams in primary forests at an altitude of about 700 meters.

A species well characterized by its narrow lanceolate leaves and its distinctly cordate floral bracts.

STROBILANTHES Blume

STROBILANTHES PACHYS C. B. Clarke in herb. Kew. sp. nov.

Suffruticosa, ramosa, inflorescentiis exceptis glabra; foliis in paribus inaequalibus, coriaceis, glabris, integris, oblongis ad oblongo-ovatis, acuminatis, basi decurrentibus, nervis utrinque 5 ad 8, majoribus 7 ad 13 cm longis, minoribus 3 ad 8 cm longis; spicis terminalibus, 3 ad 10 cm longis, circiter 1 cm diametro, densis, bracteis coriaceis, lanceolatis, 1.5 cm longis, leviter ferrugineo-pubescentibus; floribus circiter 3.5 cm longis, calycis lobis 5, liberis, anguste lanceolatis, 11 mm longis; corolla glabra; ovario oblongo, glabro, apice ferrugineo-pubescente; capsulis oblongis, 2 cm longis.

An erect, branched, suffrutescent plant, glabrous or nearly so except the inflorescences, the ultimate branches terete, brownish, about 3 mm in diameter, the very young branchlets nearly black, angled or sulcate, slightly pubescent. Leaves in unequal pairs, olivaceous, oblong to oblong-ovate, entire, both surfaces very densely covered with irregularly arranged cystoliths, glabrous, narrowed upward to the distinctly acuminate apex and below to the decurrent base, the larger ones of each pair 7 to 13 cm long, 3 to 4.5 cm wide, the smaller ones 3 to 8 cm long, 2 to 3.3 cm wide; lateral nerves of the larger leaves about 8 on each side of the midrib, of the smaller ones about 5, rather prominent, the reticulations obscure. Inflorescences terminal and terminating short lateral branches, spicate, 3 to 10 cm long, the bracts persistent, coriaceous, lanceolate, about 1.5 cm long, 4 to 5 mm wide, sparingly ferruginous-pubescent, nearly black when dry, narrowed upward to the bluntly acuminate apex. Calyx lobes free, narrowly lanceolate, subcoriaceous, 11 mm long, 2 mm wide, slightly pubescent. Corolla lavender, glabrous, 3.5 cm long, the tube narrow and cylindric in the lower 12 mm, then enlarged. Stamens 4. Ovary oblong, pubescent at the apex; style slender, sparingly villous. Capsules oblong, 2 cm long, about 3 mm in diameter, glabrous except at the very tips which are sparingly ferruginous-hirsute; seeds orbicular-ovate, about 3 mm long, appressed-pubescent with pale-brownish hairs.

LUZON, Nueva Vizcaya Province, near Imugan, *Bur. Sci. 14378 McGregor*, April, 1912. The specimen closely matches *Vidal 3012* in the Kew Herbarium bearing Clarke's unpublished manuscript name which I have adopted for the species; Vidal's specimen was from the Caraballo Sur Mountains and was probably collected on the trail between Caranglan and Dupax, hence, coming from the same general region as McGregor's specimen.

The species is very strongly characterized among the Philippine forms by its rather thickly coriaceous, entire, glabrous leaves and its elongated, spikelike inflorescences which are at most 1 cm in diameter, the persistent coriaceous, lanceolate bracts being sparingly ferruginous-pubescent.

HALLIERACANTHA Stapf

This genus, so far as known, is confined to Borneo and the Philippines, having twenty-one species in Borneo, three in Palawan, one in Mindanao and Basilan, and one in Mindoro and Luzon. My previous conception of *Polytrema* was largely based on *Polytrema aequifolium* C. B. Clarke of Palawan. Recently, in studying our Philippine and Bornean material, I concluded that this species could not be generically separated from *Hallieracantha.* A communication from Dr. O. Stapf, in answer to my queries, clears up the matter. He states that *Hallieracantha* was published in July, 1907, and *Polytrema* in November or December, 1907, and further that *Polytrema aequifolium* C. B. Clarke is a *Hallieracantha,* not a *Polytrema,* the latter genus being typified by *P. vulgare* C. B. Clarke. The Philippine forms formerly placed in *Polytrema* are here transferred to *Hallieracantha.*

HALLIERACANTHA AEQUIFOLIA (C. B. Clarke) comb. nov.

Polytrema aequifolium C. B. Clarke ex Merr. in Philip. Journ. Sci. 10 (1915) Bot. 345.

PALAWAN, *Bur. Sci. 357 Bermejos.*

HALLIERACANTHA ADDISONIENSIS (Elm.) comb. nov.

Hypoestes addisoniensis Elm. Leafl. Philip. Bot. 5 (1913) 1697.

Polytrema addisoniense Merr. in Philip. Journ. Sci. 10 (1915) Bot. 341.

PALAWAN, *Elmer 12715, Merrill 7235.*

HALLIERACANTHA ELMERI nom. nov.

Hypoestes pulgarensis Elm. Leafl. Philip. Bot. 5 (1913) 1698, non *Hallieracantha pulgarensis* Elm.

Polytrema pulgarense Merr. in Philip. Journ. Sci. 10 (1915) Bot. 342.

PALAWAN, *Elmer 12785.*

HALLIERACANTHA BREVIPETIOLATA sp. nov.

Herba erecta, ramosa, 30 ad 40 cm alta, partibus junioribus leviter pubescentibus; foliis in paribus subaequalibus, oblongis, membranaceis, utrinque cystolithis numerosis instructis, 5 ad 9 cm longis, breviter petiolatis, obtusis ad subacutis, basi plerumque obtusis, nervis utrinque circiter 6, perspicuis; petiolo 2 ad 6 mm longo; cymis breviter pedunculatis, paucifloris,

bracteis ovato-lanceolatis, 2 ad 2.5 mm longis, calycis segmentis anguste lanceolatis, acuminatis, 6 ad 7 mm longis; corolla alba, 12 mm longa, extus leviter pubescens, tubo sursum ampliato; capsulis oblanceolatis, 1.5 cm longis.

An erect branched herb 30 to 40 cm high, the younger parts sparingly pubescent, the branches terete, glabrous or nearly so, usually dark greenish when dry, the branchlets distinctly pubescent, often compressed or obscurely angular. Leaves of each pair equal or but slightly unequal, oblong, membranaceous, olivaceous, shining, 5 to 9 cm long, 2 to 3.5 cm wide, with numerous cystoliths, glabrous on both surfaces, the margins entire or very obscurely undulate, the apex obtuse to subacute, base usually obtuse, sometimes acute; lateral nerves about 6 on each side of the midrib, prominent; petioles 2 to 6 mm long, somewhat pubescent. Cymes axillary, short-peduncled, rather few-flowered, the peduncles sparingly pubescent, up to 8 mm long. Bracts ovate-lanceolate, acuminate, 2 to 2.5 mm long, the pedicels 1 to 2 mm long. Calyx segments 5, narrowly lanceolate, acuminate, somewhat pubescent, 6 to 7 mm long. Corolla white, about 12 mm long, the lower 4 mm of the tube cylindric, about 1 mm in diameter, then somewhat inflated and slightly pubescent, the whole tube about 9 mm long; the larger lobe 4.5 mm long, about 3 mm wide, cleft, the lobules oblong-ovate, 2 mm long, the smaller lobe 3-lobulate, the lobules oblong to oblong-elliptic, obtuse, 3 mm long, the middle one slightly broader than the two lateral ones. Filaments glabrous; anthers about 1.5 mm long, one cell attached slightly above the other. Capsules oblanceolate, glabrous or slightly pubescent, about 1.5 cm long, 2.5 mm in diameter, the sterile basal part 6 to 7 mm long.

MINDORO, Paluan, *Bur. Sci. 39761 Ramos*, April, 1921. In dry forests at low altitudes. A single specimen collected on Mount Maquiling, Laguna Province, Luzon, by forestry students in November, 1913, represents the same species.

A species apparently most closely allied to *Hallieracantha aequifolia* (C. B. Clarke) Merr., differing in numerous characters and readily distinguished by its much shorter petioles.

RUBIACEAE

TARENNA Gaertner

TARENNA PANGASINENSIS sp. nov.

Arbor parva circiter 4 m alta, plus minusve cinereo-pubescentibus; foliis subcoriaceis, oblongis, 7 ad 10 cm longis, supra

olivaceis, glabris, nitidis, subtus pallidis et subdense cinereo-pubescentibus, indumento nitido, apice acutis ad obscure obtuseque acuminatis, basi acutis, nervis utrinque circiter 10, subtus distinctis, junioribus plerumque in axillis glandulosis barbatisque; cymis 3 ad 4 cm longis, usque ad 4 cm diametro, cinereo-pubescentibus; floribus numerosis, subconfertis, corollae tubo 4 mm longo, glabro, fauce villoso, lobis 5, oblongo-ellipticis, 5 mm longis, calycis cinereo-pubescentibus.

A small tree about 4 m high, the branches glabrous, reddish brown to grayish, terete, the branches minutely pubescent. Leaves subcoriaceous, oblong, 7 to 10 cm long, 2 to 3.5 cm wide, subequally narrowed to the acute or very slightly acuminate apex and to the acute base, the upper surface glabrous, olivaceous, shining, the lower surface pale and uniformly cinereous-pubescent with short, appressed, shining hairs, the younger leaves usually conspicuously glandular and barbate in the axils of the veins; lateral nerves about 10 on each side of the midrib, rather slender, distinct, the reticulations lax, obscure; petioles 8 to 10 mm long, pubescent or ultimately glabrous; stipules more or less pubescent, sheathing, about 8 mm long. Inflorescences terminal, shortly peduncled, 3 to 4 cm long and 2.5 to 4 cm wide, cinereous-pubescent. Flowers white, numerous, fragrant, crowded, 5-merous, their pedicels about 2 mm long, the bracts and bracteoles minute, ovate, acuminate, 0.5 mm long. Calyx cinereous-pubescent, cup-shaped, about 2 mm long, the lobes orbicular-ovate, rounded, 0.5 mm long, their margins somewhat ciliate. Corolla tube 4 mm long, glabrous outside, the throat villous inside, the lobes oblong-elliptic, rounded, 5 mm long, spreading or reflexed. Stamens exserted, the anthers linear-oblong, 4 mm long. Style and stigma about 12 mm long, narrowly club-shaped. Ovules few.

LUZON, Pangasinan Province, Aguilar, *For. Bur. 28419 Zamuco,* April 21, 1921. Near streams at low altitudes.

This species has much the facies of *Tarenna asiatica* O. Kuntze, from which, however, it differs in numerous details and more especially in the indumentum on the lower surface of the leaves. It does not appear to be closely allied to any previously described Philippine form.

COWIEA Wernham

COWIEA PHILIPPINENSIS sp. nov.

Frutex erectus, 1 ad 3 m altus, inflorescentiis leviter ferrugineo-hirsutis exceptis glaber; foliis chartaceis ad subcoriaceis,

oblongo-ellipticis, 12 ad 18 cm longis, utrinque subaequaliter angustatis, breviter acuminatis, basi acutis ad subrotundatis, nervis utrinque 10 ad 12, perspicuis; stipulis 1 cm longis, in $\frac{1}{2}$ inferiore parte connatis, vaginatis; spicis plerumque extra-axillaribus, tenuibus, 11 ad 20 cm longis; floribus fasciculatis, fasciculis paucifloris, bracteis ovatis, acuminatis, 3 mm longis cum bracteolis lanceolatis calycibusque plus minusve ferrugineo-hirsutis, calycis profunde 5-lobatis, lobis 1.5 mm longis; corollae tubo 2 mm longo, intus haud barbato.

An erect shrub 1 to 3 m high, glabrous except the somewhat ferruginous-hirsute inflorescences. Branches terete, rather smooth, the ultimate branchlets more or less sulcate, about 2 mm in diameter. Leaves firmly chartaceous or subcoriaceous, oblong-elliptic, 12 to 18 cm long, 5 to 7 cm wide, subequally narrowed to the acute or somewhat rounded base and to the shortly acuminate apex, the upper surface olivaceous, rather dull, the lower surface paler; lateral nerves 10 to 12 on each side of the midrib, slightly raised on the upper surface, rather prominent on the lower surface, obscurely arched-anastomosing, the reticulations lax; petioles 3 to 5 mm long; stipules about 1 cm long, sheathing, united for about one-half their length, the free portions ovate, acuminate. Inflorescences chiefly extra-axillary, solitary, on the ultimate branches, usually inserted about 1 cm above the nodes, slender, 11 to 20 cm long, more or less ferruginous-hirsute, spikelike, the flowers fascicled at the nodes, sessile, the bracts subtending the fascicles ovate, acuminate, somewhat ferruginous-hirsute, about 3 mm long, the bracteoles lanceolate, acuminate, about 2 mm long. Flowers small, 5-merous, sessile or subsessile, few in a fascicle, the calyx about 2 mm long, somewhat pubescent, deeply cleft, the lobes lanceolate, about 1.5 mm long, ferruginous-hirsute. Corolla glabrous on both surfaces, the tube 2 mm long, the lobes oblong-ovate, obtuse, somewhat twisted-imbricate, 1 mm long. Anthers linear-lanceolate, 2.5 mm long, the connectives produced about 0.3 mm. Style narrowly club-shaped, grooved, glabrous, 2 mm long.

MINDANAO, Zamboanga District, Malangas and Mount Tubuan, *Bur. Sci. 36819, 36683 Ramos & Edaño*, October and November, 1919. In damp forests along streams at low altitudes.

The genus *Cowiea*, previously a monotypic one, was described from material collected by Miss Gibbs in British North Borneo,

and the Bornean species is represented in our collections by several recently collected specimens. The present species differs from *Cowiea borneensis* Wernh. in its deeply cleft calyces; its ferruginous indumentum; its corolla being glabrous, not bearded inside; and in its stipules being united into a distinct tube in the lower one-half. It is furthermore an erect shrub. In this connection, *Cowiea borneensis* Wernh. is described as scandent, but the labels on all of our recently collected Bornean material indicate an erect shrub.

IXORA Linnaeus

IXORA MYRIANTHA sp. nov.

Frutex vel arbor parva, usque ad 8 m alta, glaberrima; foliis membranaceis ad chartaceis, 9 ad 17 cm longis, oblongis ad oblongo-ellipticis, acuminatis, basi plerumque acutis, nervis utrinque circiter 10, subtus perspicuis, foliis superioribus plerumque brevissime petiolatis, basi late rotundatis; inflorescentiis pedunculatis, multifloris, 4 ad 8 cm latis, floribus albidis, confertis, bracteis bracteolisque lanceolatis, 1 mm longis; calycis 1.2 mm longis, lobis acutis, brevibus; corollae tubo 12 mm longo, lobis late lanceolatis ad oblongo-lanceolatis, acuminatis, 5 mm longis.

An entirely glabrous shrub or small tree reaching a height of 8 m, the branches and branchlets rather slender, usually brownish, terete. Leaves membranaceous to chartaceous, oblong to oblong-elliptic, 9 to 17 cm long, 3.5 to 6 cm wide, usually brownish when dry, somewhat shining, narrowed upward to the blunt-acuminate apex and below to the acute base; lateral nerves about 10 on each side of the midrib, rather distant, arched-anastomosing, prominent on the lower surface, the reticulations lax, distinct; petioles 10 to 12 mm long; stipules lanceolate-acuminate from an ovate base, 5 to 6 mm long. The upper pair of leaves subtending the inflorescences are in general similar to the normal leaves but are subsessile or shortly petioled and with broadly rounded bases. Inflorescences terminal, peduncled, many-flowered, 4 to 8 cm wide, the peduncles 4 to 5 cm in length, the bracts subtending the branches narrowly lanceolate, acuminate, 4 to 7 mm long. Flowers rather crowded, white, their pedicels about 2 mm long, the bracts and bracteoles lanceolate, acuminate, 1 mm in length. Calyx glabrous, cup-shaped, 1.2 mm long, 4-toothed, the teeth triangular, acute or acuminate, about one-third as long as the tube. Corolla

white, the tube 12 mm long, rather slender, nearly black when dry, the lobes lanceolate to oblong-lanceolate, acuminate, 5 mm long, 2 mm wide. Anthers linear-lanceolate, up to 3.5 mm in length.

SAMAR, *Merrill Phil. Pl. 1700* (type), April, 1914, *Bur. Sci. 24122, 24139 Ramos & Edaño,* February, 1916. In damp forests at low altitudes.

A species apparently most closely allied to *Ixora cumingiana* Vid., differing especially in its crowded shorter flowers.

PLEIOCARPIDIA K. Schumann

PLEIOCARPIDIA LANAENSIS sp. nov.

Arbor parva, usque ad 12 m alta, partibus junioribus et subtus foliis ad costa nervisque plus minusve pubescentibus; foliis oblongis, coriaceis, 15 ad 30 cm longis, 5 ad 11 cm latis, acuminatis, basi acutis ad late rotundatis, nervis utrinque 15 ad 18, subtus valde perspicuis; inflorescentiis paniculatis, 4 ad 8 cm longis, pedunculatis, floribus polygamis, plerumque 7-meris, ♂ calycis 3 mm diametro, cinereo-pubescentibus, corollae tubo 2 mm longo, lobis lanceolatis, 3 mm longis, intus villosis; disco puberulo; fructibus globosis, 6 ad 7 mm diametro, subglabris.

A small tree attaining 12 m in height, the younger parts, inflorescences and the leaves on the midrib and nerves beneath more or less pubescent. Branches terete, rather stout, smooth, glabrous, brownish or grayish, the ultimate branchlets 2.5 to 4 mm in diameter, often compressed or sulcate. Leaves oblong, coriaceous, 15 to 30 cm long, 5 to 11 cm wide, usually pale when dry, the upper surface glabrous, the apex shortly acuminate, base acute to rounded; lateral nerves 15 to 18 on each side of the midrib, somewhat curved, very prominent on the lower surface, the reticulations distinct; petioles 1.5 to 2 cm long, more or less pubescent; stipules oblong or ovate, 6 to 8 mm long, obtuse or acute. Inflorescences axillary, peduncled, cymose, more or less pubescent, 4 to 8 cm long, 3 to 6 cm wide, somewhat pyramidal, many-flowered, the peduncles usually about 1 cm long. Flowers apparently polygamous, usually 7-merous, the calyx of the staminate ones about 3 mm in diameter, shallowly cup-shaped, truncate or obscurely toothed. Corolla about 5 mm long, the tube 2 mm in length, the lobes usually 7, lanceolate, 3 mm long, densely villous at the throat inside. Filaments 3 mm long, the anthers 1 mm in length. Disk prominent, cushion-shaped, puberulent, not lobed, about 1.5 mm in diameter. Calyces of the perfect flowers somewhat urceolate; style about

1.3 mm long, the stigma 1 mm in diameter. Fruits globose, 6 to 7 mm in diameter, nearly glabrous, crowned by the shallow calyx limb and the prominent, puberulent disk.

MINDANAO, Lanao District, *Mrs. Clemens 882* (type), January, 1907; Zamboanga District, *Merrill 8064, 8098,* December, 1911, *Bur. Sci. 37226 Ramos & Edaño,* November, 1918: Bukidnon Subprovince, *38988 Ramos & Edaño,* June, 1920. In forests and along streams at low and medium altitudes, ascending to 800 meters.

This species is manifestly allied to *Pleiocarpidia enneandra* (Wight) K. Schum. of the Malay Peninsula, Sumatra, and Borneo, differing among other characters in its leaves being more or less pubescent beneath, and in its usually 7-merous flowers. It is somewhat intermediate between *Pleiocarpidia* and *Urophyllum,* the two genera being very closely allied; perhaps *Pleiocarpidia* should be merged in *Urophyllum.* The specimens cited above were all distributed as *Urophyllum. Aulacodiscus* Hook. f. non Ehrenb. must be replaced by *Pleiocarpidia* if this group is to be retained as generically distinct from *Urophyllum.*

GARDENIA Linnaeus

GARDENIA MEGALOCARPA sp. nov.

Arbor parva, ramulis et subtus foliis molliter pubescentibus; foliis chartaceis vel submembranaceis, obovatis ad oblongo-obovatis, 15 ad 22 cm longis, acuminatis, basi cuneatis, supra olivaceis, nitidis, glabris, nervis utrinque 18 ad 22, perspicuis; fructibus ellipsoideis, magnis, glabris, leviter 5-carinatis, circiter 7 cm longis, calycis lobis persistentibus, pubescentibus, profunde carinatis, carinis productis, anguste oblongis, falcatis, 1.5 cm longis, 4 mm latis. Species G. carinatae Wall. affinis.

A small tree, the branchlets and the lower surface of the leaves softly pubescent, the ultimate branchlets 4 to 5 mm in diameter, grayish. Leaves chartaceous or subcoriaceous, obovate to oblong-obovate, 15 to 22 cm long, 6 to 10 cm wide, the apex distinctly acuminate, the base cuneate, the upper surface glabrous, olivaceous, shining, the lower surface somewhat paler, the indumentum largely confined to the midrib, nerves, and reticulations; lateral nerves 18 to 22 on each side of the midrib, prominent on the lower surface, spreading or somewhat ascending, the primary reticulations subparallel, slender; petioles pubescent, 1 to 1.3 cm long; stipules 1 to 1.5 cm long, somewhat sheathing, pubescent. Fruits solitary, in the uppermost axils, shortly peduncled, ellipsoid, glabrous, orange-red when

fresh, brownish when dry, about 7 cm long, 4.5 cm in diameter, longitudinally 5-ridged, the ridges conspicuous near the apex of the fruit, obscure or nearly obsolete in the lower part of the fruit, the persistent calyx lobes pubescent, deeply carinate, the keels produced, narrowly oblong, falcate, 1.5 cm long, 4 mm wide, obtuse.

MINDORO, Paluan, *Bur. Sci. 38919 Ramos,* April 22, 1921. In forests at low altitudes.

A species manifestly allied to *Gardenia carinata* Wall., but readily distinguished by its much larger fruits.

UROPHYLLUM Wallich

UROPHYLLUM MINDORENSE sp. nov.

Frutex subglaber, partibus junioribus inflorescentiisque parcissime pubescentibus; foliis oblongis ad oblongo-ellipticis, 7 ad 11 cm longis, membranaceis, olivaceis, utrinque glabris, acuminatis, basi late acutis, nervis utrinque 8 ad 10, perspicuis, stipulis anguste lanceolatis, deciduis, 3 mm longis; floribus fasciculatis, pedicellatis, bracteis lineari-lanceolatis, 2 ad 3 mm longis; calycis cupulatis, 4 mm longis, 4-lobatis; corolla 8 mm longa, 5-lobata, extus glabra, intus barbata, lobis oblongo-ovatis, acutis, 3.5 ad 4 mm longis.

A nearly glabrous shrub, the very young parts and the inflorescences obscurely pubescent, the branches slender, pale or greenish, glabrous. Leaves oblong to oblong-elliptic, membranaceous, 7 to 11 cm long, 3 to 5 cm wide, olivaceous, shining, entirely glabrous on both surfaces, the very young ones slightly pubescent, apex rather slenderly acuminate, the base broadly acute; lateral nerves 8 to 10 on each side of the midrib, spreading, rather prominent on the lower surface, anastomosing, the primary reticulations rather lax, distinct; petioles glabrous, 1 to 1.8 cm long; stipules narrowly lanceolate, acuminate, about 3 mm long. Flowers white, in axillary fascicles, pediceled, the pedicels very slightly pubescent, 2 to 5 mm long, the subtending bracts linear-lanceolate, acuminate, 2 to 3 mm long. Calyx cup-shaped, about 4 mm long, 4-lobed, the lobes about 2 mm wide, 1 mm long, shortly acuminate. Corolla 8 mm long, glabrous outside, the tube 4 to 4.5 mm long, somewhat expanded above the calyx rim, the throat densely villous inside, the lobes 5, oblong-ovate, acute, 3.5 to 4 mm long, bearded at the base inside. Anthers 1.5 mm long including the rather conspicuous produced connective.

MINDORO, Mount Calavite, *Bur. Sci. 39279* (type), *39398 Ramos*, April, 1921. On forested slopes, altitude 600 to 700 meters.

A species belonging in the group with *Urophyllum acuminatum* Merr., but with broader, more numerously nerved, differently shaped, not caudate-acuminate leaves, and nearly glabrous throughout.

ARGOSTEMMA Wallich

ARGOSTEMMA ARACHNOSUM sp. nov.

Herba simplex, suberecta, usque ad 20 cm alta, subtus foliis ad costa nervisque dense arachnoso-villosis; foliis numerosis, oblongis ad oblongo-ellipticis, 4.5 ad 8 cm longis, in paribus subaequalibus, obtusis ad brevissime acuminatis, nervis utrinque circiter 8, subtus perspicuis; inflorescentiis longe pedunculatis, cymosis, 1.5 ad 3 cm longis, arachnoso-villosis, pedunculo usque ad 9 cm longo, glabro; floribus 5-meris, pedicellis villosis, 10 ad 12 mm longis.

A simple, suberect herb, up to 20 cm high, the stems usually decumbent below, about 3 mm in diameter, the younger parts more or less villous or hirsute. Leaves numerous, in scattered pairs, those of each pair equal or subequal, oblong to oblong-elliptic, obtuse or very shortly acuminate, membranaceous or chartaceous, 4.5 to 8 cm long, 1.8 to 2.5 cm wide, the base acute to rounded, the upper surface usually black when dry, sparingly villous along the midrib or entirely glabrous, the lower surface very conspicuously and densely villous with dirty-brown, crisped, cobwebby hairs on the midrib, nerves, and reticulations; lateral nerves about 8 on each side of the midrib, prominent on the lower surface; petioles 1 to 2 cm long, villous; stipules oblong, about 8 mm long, 4 mm wide, acuminate. Inflorescences terminal, cymose, the cymes rather densely flowered and umbelliform, villous, 1.5 to 3 cm long; peduncles elongated, glabrous, 5 to 9 cm long, often with a whorl of membranaceous, oblong-ovate, 4 to 5 mm long bracts at about the middle, the bracts subtending the branches oblong to oblong-lanceolate, 2.5 to 5 mm long, the bracteoles broadly ovate, obtuse, 2 mm long. Flowers 5-merous, their pedicels villous, 10 to 12 mm long. Calyx about 2.2 mm in diameter, densely villous, the lobes broadly ovate, spreading, glabrous inside, 1 mm long. Fruit about 4 mm long and wide, somewhat cup-shaped, the calyx limb well produced above the fruit.

MINDANAO, Zamboanga District, Malangas, *Bur. Sci. 36830* (type), *37331 Ramos & Edaño,* October and November, 1919. Along small streams at low altitudes.

A species strongly characterized by its midribs, nerves, and reticulations on the lower surface of the leaves being densely cobwebby-villous and, hence, very conspicuous, as well as by its long-peduncled inflorescences. It belongs in the general group with *Argostemma urticifolium* King and *A. teysmannianum* Miq.

LASIANTHUS Jack

LASIANTHUS MINDANAENSIS sp. nov.

Frutex 2 m altus, ramis ramulisque subdense adpresse hirsutis; foliis chartaceis vel subcoriaceis, lanceolatis, caudato-acuminatis, 11 ad 18 cm longis, 2.5 ad 4 cm latis, basi acutis, supra olivaceis, glabris, subtus ad costa et nervis reticulisque adpresse-villosis, nervis utrinque 7, curvato-adscendentibus, perspicuis; floribus axillaribus, paucis, sessilibus, 5-meris, bracteis bracteolisque lanceolatis, acuminatis, villosis, bracteis 8 mm longis, persistentibus; calycis tubo glabro, lobis 2 mm longis, villosis; fructibus subovoideis, 5 mm longis.

A shrub about 2 m high, the branches and branchlets terete, rather densely appressed-hirsute with brown hairs, the ultimate branchlets about 2 mm in diameter. Leaves chartaceous to subcoriaceous, lanceolate, 11 to 18 cm long, 2.5 to 4 cm wide, the apex slenderly caudate-acuminate, the base acute, the upper surface olivaceous, glabrous, shining, the lower surface appressed-villous on the midrib, nerves, and reticulations, the indumentum on the midrib brownish, on the nerves and reticulations yellowish green; lateral nerves 7 on each side of the midrib, curved-ascending, prominent, the reticulations rather distinct on the lower surface; petioles 10 to 12 mm long, densely appressed-villous with brown hairs; stipules ovate, acuminate, 3 to 4 mm long, persistent, densely appressed-villous outside. Flowers few, in axillary sessile fascicles, the subtending bracts narrowly lanceolate, acuminate, appressed-villous, persistent, about 8 mm long, the bracteoles similar but only half as long. Fruits subovoid, glabrous, 5 mm long, crowned by the villous persistent calyx teeth.

MINDANAO, Bukidnon Subprovince, Mount Candoon, *Bur. Sci. 38795 Ramos & Edaño,* June, 1920. In damp forests, altitude about 1,000 meters.

A species somewhat resembling *Lasianthus morus* Elm., but differing distinctly in its indumentum and in its calyx lobes. It differs from *Lasianthus acuminatissimus* Merr. in its indumentum, wider leaves, very different stipules, and conspicuous, persistent bracts and bracteoles.

LASIANTHUS ACUMINATISSIMUS sp. nov.

Frutex circiter 1 m altus, ramis ramulisque minute et obscure adpresse hirsutis; foliis chartaceis, anguste lanceolatis, 9 ad 20 cm longis, 1.5 ad 3 cm latis, sursum sensim angustatis, tenuiter caudato-acuminatis, basi acutis, supra olivaceis, glabris, subtus ad costa et nervis reticulisque breviter pubescentibus, nervis utrinque circiter 7, curvato-adscendentibus, perspicuis; floribus paucis, fasciculatis, sessilibus, 5-meris, ebracteolatis, calycis breviter 5-dentatis, corollae tubo cylindrico, 5 mm longo, intus villoso, lobis oblongis, 3 mm longis, intus villosis.

An erect shrub about 1 m high, the branches and branchlets terete, brownish or olivaceous when dry, minutely and obscurely appressed-hirsute with short hairs, the ultimate branchlets 1.5 to 2 mm in diameter. Leaves chartaceous, narrowly lanceolate, 9 to 20 cm long, 1.5 to 3 cm wide, gradually narrowed upward to the slenderly caudate-acuminate apex, the base acute, the upper surface olivaceous, glabrous, somewhat shining, the lower surface shortly pubescent on the midrib, nerves, and reticulations, the indumentum yellowish green; lateral nerves about 7 on each side of the midrib, curved-ascending, distinct on both surfaces as are the reticulations; petioles more or less pubescent, 5 to 7 mm long; stipules linear to linear-lanceolate, pubescent, nearly as long as the petioles, deciduous. Flowers few, white, in axillary sessile fascicles, 5-merous. Calyx 3 mm long, slightly pubescent, the teeth triangular, acute, 0.5 mm long, their margins slightly ciliate. Corolla tube cylindric, somewhat pubescent externally, about 5 mm long, glabrous inside in the lower half, villous in the upper half, the lobes oblong, 3 mm long, villous inside. Anthers oblong, 2.2 mm long. Disk cushion-shaped, 1 mm long, glabrous. Style 6 mm in length.

LUZON, Bontoc Subprovince, Mount Caua, *Bur. Sci. 38058 Ramos & Edaño,* March, 1920. In the mossy forest, altitude about 1,800 meters.

A species belonging in the general group with *Lasianthus morus* Elm., well characterized, however, by its elongated, narrowly lanceolate, caudate-acuminate leaves.

HEDYOTIS Linnaeus

HEDYOTIS CAMARINENSIS sp. nov.

Suffruticosa, subscandens, stipulis inflorescentiisque plus minusve hirsutis exceptis glabra; caulis teretibus, laevis, 4 mm diametro, ramulis plus minusve compressis vel sulcatis; foliis chartaceis ad subcoriaceis, lanceolatis, usque ad 10 cm longis et 3 cm latis, breviter petiolatis, acutis vel obscure acuminatis, basi acutis, nervis utrinque 5, adscendentibus, perspicuis, reticulis obsoletis; stipulis latis, pectinatis, laciniae circiter 7, hirsutae, longioribus 6 ad 9 mm longae; inflorescentiis axillaribus, cymis laxis, 1 cm longis, paucifloris, leviter hirsutis, calycis lobis oblongo-lanceolatis, acuminatis, 1.5 ad 2 mm longis.

A suffrutescent, scandent plant at least 1 m high, glabrous except the stipules and inflorescences. Stems terete, smooth, dark-colored, about 4 mm in diameter, the younger branchlets usually compressed or sulcate. Leaves chartaceous to subcoriaceous, lanceolate, 7 to 10 cm long, 2 to 3 cm wide, greenish olivaceous, smooth, glabrous, slightly shining, the lower surface paler than the upper, the apex acute or slightly acuminate, the base acute; lateral nerves 5 on each side of the midrib, ascending, scarcely anastomosing, prominent, the reticulations obsolete; petioles stout, 3 to 4 mm long; stipules broad, the body about 3 mm long, 6 to 9 mm wide, glabrous, subtruncate, pectinate, the lobes about 7, linear, stiff, more or less hirsute, the inner ones 6 to 9 mm long, the outer ones gradually shorter, a few intermediate ones often present, 1 mm or less in length. Cymes axillary, lax, few-flowered, about 1 cm long, sparingly hirsute, the pedicels 2 to 3 mm long, slender. Calyx tube about 1 mm long, glabrous or nearly so, the lobes 4, oblong-lanceolate, somewhat acuminate, slightly hirsute, 1.5 to 2 mm long. Capsules globose, 1.5 mm in diameter, crowned by the persistent calyx lobes.

LUZON, Camarines Province, Paracale, *Bur. Sci. 33604 Ramos & Edaño,* December, 1918. In damp soil in new clearings near thickets at low altitudes.

The specimens were originally identified as *Hedyotis rigida* Miq., but represent a species rather remote from the one described by Miquel. It is strongly characterized by its short petioles, glabrous, lanceolate, acute, prominently and obliquely nerved leaves, the reticulations being obsolete, as well as by its stipule and inflorescence characters.

HEDYOTIS BAMBUSETORUM sp. nov.

Suffruticosa, ramosa, usque ad 1 m alta, inflorescentiis leviter hirsutis exceptis glabra, caulis teretibus, laevis, 4 mm diametro, ramulis teretibus vel leviter compressis vel sulcatis; foliis oblongo-ovatis ad ovato-lanceolatis, usque ad 17 cm longis, chartaceis, in siccitate olivaceis, nitidis, fragilis, tenuiter acute acuminatis, basi acutis ad subrotundatis, nervis utrinque 6 vel 7, curvato-adscendentibus, utrinque elevatis; stipulis latis, pectinatis, laciniae circiter 13, 7 ad 8 mm longae, glabrae, glanduliferae; inflorescentiis axillaribus, sessilibus, globosis, 1 ad 1.5 cm diametro; floribus numerosis, confertis, 5 mm longis, calycis lobis 4, lanceolatis, obscure hirsutis, 2 mm longis.

A suffrutescent, erect, branched plant up to 1 m high, glabrous except the very slightly hirsute inflorescences, the stems smooth, terete, subolivaceous, 4 mm in diameter, the branchlets terete or slightly compressed or sulcate. Leaves oblong-ovate to ovate-lanceolate, chartaceous, 9 to 17 cm long, 3 to 5 cm wide, when dry olivaceous, shining, fragile, smooth, the apex slenderly and acutely acuminate, the base acute to somewhat rounded or even decurrent; lateral nerves 6 or 7 on each side of the midrib, curved-ascending, projecting on both surfaces, slender but distinct, obscurely anastomosing, the reticulations lax, not prominent; petioles of the larger leaves 1 to 1.5 cm long; stipules broadly triangular, glabrous, about 8 mm wide, the body about 5 mm long, pectinate, the segments about 13, linear, the median ones longer, 7 to 8 mm long, the outer ones shorter, 3 to 4 mm long, all gland-tipped. Inflorescences axillary, globose, sessile, dense, 1 to 1.5 cm in diameter. Flowers white, numerous, crowded, the bracteoles lanceolate, acuminate, 4 to 6 mm long, slightly hirsute, the pedicels 1 mm long or less. Flowers about 5 mm long, 4-merous. Calyx tube glabrous, 1.5 mm long, the lobes lanceolate, about 2 mm long, glabrous or slightly hirsute. Corolla tube slender, glabrous, 3 mm long, the throat and lobes slightly bearded inside, the lobes oblong-lanceolate, 1.5 mm long. Style glabrous, 5 mm long.

PALAWAN, Taytay, *Merrill 9214*, April, 1913. Along trails in bamboo thickets at low altitudes.

A species apparently most closely allied to the Bornean *Hedyotis platyphylla* Merr., but differing in its branches, its terete stems, more numerous segments of its stipules, shorter petioles, and in its nerves not being impressed on the upper surface.

OPHIORRHIZA Linnaeus

OPHIORRHIZA DOLICHOPHYLLA sp. nov.

Planta suffruticosa, erecta, simplex, usque ad 50 cm alta, inflorescentiis leviter pubescentibus exceptis glabra; foliis membranaceis, utrinque olivaceis, nitidis, lineari-lanceolatis, 20 ad 25 cm longis, 7 ad 10 mm latis, sursum sensim angustatis, tenuiter caudato-acuminatis, basi decurrentibus, nervis obscuris; cymis sessilibus, leviter ferrugineo-pubescentibus, 3 cm longis; fructibus 7 mm latis, 3 ad 4 mm longis, subtruncatis.

An erect, unbranched, suffrutescent plant, 40 to 50 cm long, glabrous except the sparingly pubescent inflorescences, the stems about 3 mm in diameter. Leaves linear-lanceolate, membranaceous, olivaceous and shining on both surfaces, 20 to 25 cm long, 7 to 10 mm wide, entire, narrowed upward to the very slenderly caudate-acuminate apex and below to the decurrent base, the midrib rather prominent on both surfaces, the lateral nerves distant, obscure; petioles 1 cm long or less; stipules 5 to 7 mm long, divided into from 3 to 5 linear segments. Cymes terminal, sessile, sparingly ferruginous-pubescent, in fruit up to 3 cm long, the fruits subtruncate, compressed, about 7 mm wide, 3 to 4 mm long, glabrous or nearly so.

MINDANAO, Zamboanga District, Mount Tubuan, *Bur. Sci. 36565 Ramos & Edaño,* October, 1919. On bowlders along small streams at low altitudes.

A remarkable species, strongly characterized by its greatly elongated, linear-lanceolate, narrow, slenderly caudate-acuminate leaves.

CUCURBITACEAE

ALSOMITRA M. Roemer

ALSOMITRA SIMPLICIFOLIA sp. nov.

Frutex scandens, glaber; foliis ellipticis, integris, 10 ad 18 cm longis, apice breviter obtuse acuminatis apiculatisque, basi cordatis; inflorescentiis solitariis, 20 ad 30 cm longis, depauperato-paniculatis, ramis paucis, inferioribus usque ad 2 cm longis; fructibus sessilibus, truncatis, 3.5 cm longis, circiter 1.5 cm latis, basi acutis, in siccitate brunneis.

A scandent, somewhat woody, glabrous vine, the branches lenticellate, up to 5 mm in diameter. Leaves simple, firmly chartaceous, elliptic, entire, 10 to 18 cm long, 4.5 to 10 cm wide, the apex bluntly acuminate and minutely apiculate, the base 3-nerved, cordate, the sinus up to 1.5 cm wide, rather

shallow, the lobes rounded to subacute; lateral nerves above the basal pair 2 or 3 on each side of the midrib, slender, distinct, the reticulations lax; petioles 2 to 4 cm long; tendrils 5 to 21 cm long. Inflorescences slender, solitary, from the axils of fallen leaves, 20 to 30 cm long, the flowers racemosely arranged in the upper part, in the lower part usually few and scattered, primary branches up to 2 cm in length. Buds rather thickly club-shaped, about 7 mm long. Fruits brown when dry, sessile or subsessile, truncate, smooth, 3.5 cm long, about 1.5 cm wide, base acute.

MINDANAO, Zamboanga District, Malangas, *Bur. Sci. 37397 Ramos & Edaño,* November 3, 1919. In forests along streams at low altitudes, locally known as *lalapid.*

This species is manifestly most closely allied to *Alsomitra timorana* (Spanog.) Roem., from which it differs, among other characters, in its entire and very shortly acuminate leaves.

GYNOSTEMMA Blume

GYNOSTEMMA LAXUM (Wall.) Cogn. in DC. Monog. Phan. 3 (1881) 914.
Zanonia laxa Wall. Cat. (1831) no. 3727, nomen, Pl. Rar. As. 2 (1831) 29.

MINDANAO, Bukidnon Subprovince, Mahilucot River, *Bur. Sci. 38643, 38669 Ramos & Edaño,* July, 1920. Altitude about 1,000 meters, in forests along streams. Local name *pogsot.*

India to Sumatra, Java, and Borneo.

CAPRIFOLIACEAE

LONICERA Linnaeus

LONICERA MINDANAENSIS sp. nov. § *Nintooa, Breviflorae.*

Frutex scandens, partibus junioribus inflorescentiisque exceptis glaber; foliis chartaceis vel subcoriaceis, olivaceis, nitidis, utrinque glabris, oblongo-ovatis vel oblongis, 3.5 ad 6 cm longis, basi late rotundatis, apice acutis; floribus terminalibus et in axillis superioribus, 2.3 ad 2.5 cm longis, bracteis triangulari-ovatis, acuminatis, bracteolis orbiculari-reniformibus, late rotundatis, 1 mm diametro, corolla extus adpresse villosa.

A scandent shrub, glabrous except the sparingly pubescent younger parts and the inflorescences and flowers. Branches terete, smooth, reddish brown, glabrous, the branchlets slightly appressed-pubescent. Leaves chartaceous to subcoriaceous, oblong-ovate to oblong, 3.5 to 6 cm long, 1.5 to 3 cm wide, olivaceous and shining on both surfaces, glabrous, base broadly rounded, apex acute; lateral nerves slender, about 8 on each

side of the midrib; petioles 2 to 3 mm long, slightly pubescent. Flowers white and yellow, in 2-flowered cymes which are terminal and in the uppermost axils forming a few-flowered leafy inflorescence, the peduncles of the cymes somewhat pubescent, up to 8 mm long. Bracts triangular-ovate, acuminate, ciliate, about 2 mm long; bracteoles orbicular-reniform, broadly rounded, about 1 mm in diameter. Calyx 2 to 2.5 mm long, the tube glabrous, the teeth ovate, acute, 0.8 mm long, slightly pubescent. Corolla tube about 1 cm long, terete, somewhat enlarged upward, appressed-pubescent outside with short, brownish, retrorse, appressed hairs, villous inside, the lower lip about 12 mm long and 2 mm wide, the upper lip up to 7 mm wide, divided into 4 short, ovate, obtuse lobes which do not exceed 4 mm in length, the two lateral ones somewhat falcate. Filaments villous, except in the upper part, the hairs spreading; anthers 3.5 to 4 mm long. Style about 2.5 cm long, the upper 8 to 10 mm glabrous, the lower part villous with spreading hairs; stigma about 1.5 mm in diameter.

MINDANAO, Bukidnon Subprovince, Mount Dumalupihan, *Bur. Sci. 39024 Ramos & Edaño,* July 29, 1920. On forested slopes, altitude about 1,200 meters; local name *gauod bukid.*

The third species of the genus to be found in the Philippines, most closely allied to *Lonicera rehderi* Merr., from which it differs in its glabrous leaves. From both *Lonicera rehderi* Merr. and *L. philippinensis* Merr. it differs in its larger flowers.

CAMPANULACEAE

PENTAPHRAGMA Wallich

PENTAPHRAGMA MINDANAENSE sp. nov.

Frutex erectis circiter 50 cm altus, partibus junioribus plus minusve crispato-pubescentibus; foliis inaequilateralibus, ellipticis ad oblongo-ellipticis, 15 ad 20 cm longis, integris, in siccitate membranaceis, subacutis vel breviter obtuseque acuminatis, basi subacutis, nervis utrinque 2 ad 4, adscendentibus; racemis usque ad 5 cm longis, haud scorpoideis; floribus circiter 8 mm longis, bracteis membranaceis, 6 ad 8 mm longis; calycis lobis oblongo-ovatis, obtusis, membranaceis, petalis aequantibus; petalis incrassatis, oblongo-ovatis, acuminatis, glabris, 3 mm longis.

A small erect undershrub, about 50 cm high, the younger parts more or less pubescent with crisped hairs, the stem brown, rather smooth, terete, about 6 mm in diameter, distinctly woody. Leaves somewhat inequilateral, elliptic to oblong-elliptic, 15 to 20 cm long, 7 to 9 cm wide, entire, membranaceous when dry,

pale brownish, the apex subacute to very shortly and obtusely acuminate, the base subacute, often slightly inequilateral; lateral nerves 2 or 3 on each side of the midrib, or sometimes 4 on the broader side of the leaf, prominent, ascending; petioles about 3 cm long, pubescent. Racemes in the upper axils, up to 5 cm long, the flowers white, scarcely scorpoid in arrangement, about 8 mm long, the bracts spatulate to oblong-oblanceolate or often narrowly obovate, membranaceous, somewhat pubescent, 6 to 8 mm long. Pedicels 3 mm long or less. Calyx somewhat pubescent, the base cuneate, the lobes oblong-ovate, obtuse, membranaceous, about equaling the petals. Petals much thickened, oblong-ovate, acuminate, glabrous, about 3 mm long.

MINDANAO, Zamboanga District, Malangas and Mount Tubuan, *Bur. Sci. 36834* (type), *36580 Ramos & Edaño,* October, 1919. Along small streams in forests at low altitudes.

Among the few Philippine species of this genus the present one is most closely allied to *Pentaphragma pulgarense* Elm. of Palawan.

COMPOSITAE

VERNONIA Schreber

VERNONIA BONTOCENSIS sp. nov.

Frutex scandens, ramis leviter pubescentibus, parce lenticellatis, ramulis dense sordide pubescentibus; foliis membranaceis ad chartaceis, oblongis ad oblongo-ellipticis, 5 ad 9 cm longis, atro-olivaceis, integris, acutis vel acuminatis, basi acutis, subtus eglandulosis, nervis utrinque circiter 6, reticulis ultimis cystolithiformis; inflorescentiis axillaribus terminalibusque, capitulis paucis (2 ad 5), racemose dispositis; capitulis 14 mm longis, cylindraceis, circiter 8-floris, bracteis interioribus 7 mm longis, margine et apice pubescentibus; acheniis 4 mm longis, perspicue glandulosis.

A scandent, woody vine, the branches grayish brown, terete, longitudinally striate, slightly pubescent, very sparingly lenticellate, the ultimate branchlets 1.5 to 2 mm in diameter, densely pubescent with short, dirty brown hairs. Leaves membranaceous to chartaceous, oblong to oblong-elliptic, 5 to 9 cm long, 2 to 3.5 cm wide, dark olivaceous, slightly shining, subequally narrowed to the acute or shortly acuminate apex and the cuneate base, the margins entire, the upper surface entirely glabrous, the lower surface sparingly pubescent on the midrib and nerves, eglandular, the ultimate reticulations on the lower surface distinctly cystolith-like; lateral nerves about 6 on each side of the

midrib, rather prominent, anastomosing, the primary reticulations lax, distinct; petioles pubescent, 8 to 10 mm long. Inflorescences terminal and in the leaf axils on the ultimate branchlets, the individual ones short, 2 to 4 cm in length, each composed of from 2 or 3 to 5 racemosely arranged heads, the peduncles pubescent, up to 1 cm in length. Heads about 14 mm long, approximately 8-flowered, subcylindric, the outer bracts ovate, 2 mm long, distinctly pubescent, the inner ones gradually longer, the innermost about 7 mm long, 3 mm wide, acute, their margins and tips more or less pubescent; achenes 4 mm long, with numerous, shining, yellowish glands, the pappus copious, about 6 mm long, straw-colored or pale brownish.

LUZON, Bontoc Subprovince, Mount Pukis, *Bur. Sci. 37752 Ramos & Edaño*, March, 1920, on open slopes, altitude about 1,300 meters.

A species most closely allied to *Vernonia lenticellata* Elm., but with somewhat larger leaves and larger heads, the peduncles also longer in the present species. It differs further in the cystolith-like ultimate reticulations; its very sparingly lenticellate branches; and in the involucral bracts being pubescent chiefly on the margins and at their apices.

VERNONIA MINDANAENSIS sp. nov.

Frutex scandens, partibus junioribus sordide pubescentibus; foliis chartaceis ad subcoriaceis, oblongis ad oblongo-obovatis, integris, 6 ad 8 cm longis, acuminatis, basi acutis, subtus eglandulosis, pubescentibus, nervis utrinque circiter 5; inflorescentiis paniculatis, usque ad 18 cm longis; capitulis, numerosis, 1.5 ad 1.7 cm longis, circiter 20-floris; bracteis dense cinereo-pubescentibus, interioribus 10 mm longis; acheniis glabris, sulcatis, 4 mm longis. Species V. philippinensis affinis differt acheniis glaberrimis.

A woody vine reaching a height of 10 m, the branches dark reddish brown, striate, terete, somewhat pubescent, the ultimate branchlets 2 to 3 mm in diameter, rather densely pubescent with short, dirty brown hairs. Leaves chartaceous to subcoriaceous, oblong to oblong-obovate, entire, 6 to 8 cm long, 2.5 to 3.5 cm wide, the apex shortly acuminate, base cuneate, the upper surface dark olivaceous, shining, nearly glabrous except for the sparingly pubescent midrib and nerves, the lower surface paler, eglandular, with scattered pubescence on all parts but more especially on the midribs, nerves, and reticulations; lateral nerves about 5 on each side of the midrib, curved-anastomosing, distinct,

as are the primary reticulations; petioles pubescent, 5 to 10 mm long. Heads arranged in somewhat leafy panicles terminating the branchlets, the panicles rather densely pubescent, up to 18 cm long, the peduncles up to 1 cm in length. Heads 1.5 to 1.7 cm long, about 20-flowered, the outer bracts oblong to oblong-ovate, 2 mm long, the inner ones lanceolate, acuminate, about 10 mm long, 2.3 mm wide, all rather densely cinereous-pubescent. Achenes 4 mm long, longitudinally sulcate, entirely glabrous; pappus copious, somewhat tawny, about 10 mm long.

MINDANAO, Bukidnon Subprovince, Mount Candoon, *Bur. Sci. 38886* (type) *Ramos & Edaño,* June, 1920: Lanao District, Camp Keithley, *Mrs. Clemens 1086,* May, 1907. In damp forests at an altitude of about 1,000 meters. Locally known in Bukidnon as *gauod.*

A species belonging in the group with *Vernonia philippinensis* Rolfe, apparently most closely allied to that species, differing especially in its entirely glabrous achenes.

LACTUCA Linnaeus

LACTUCA INTEGRA sp. nov.

Herba erecta, glabra, ramosa, usque ad 40 cm alta; foliis chartaceis, lanceolatis ad oblongo-lanceolatis, acutis vel leviter acuminatis, usque ad 7 cm longis, radicalibus numerosis, petiolatis, confertis, caulinis quam radicalibus multo minoribus, sessilibus, nervis reticulisque obscuris; capitulis corymbose-paniculatis, pedicellatis, 6 ad 7 mm longis, bracteis exterioribus parvis, interioribus plerumque 8, circiter 6 mm longis, glabris, anguste oblongis, obtusis; acheniis oblongis, 3 ad 3.5 mm longis, longitudinaliter costatis, glabris, sursum leviter angustatis.

An erect, glabrous, branched herb about 40 cm high, olivaceous or brownish olivaceous when dry. Radical leaves very numerous, crowded, chartaceous, lanceolate, subequally narrowed at both ends, 5 to 7 cm long, 1 to 1.5 cm wide, entire, shining, acute, base decurrent; petioles up to 2 cm long; lateral nerves slender, obscure, anastomosing. Stem leaves much smaller than the radical ones, lanceolate to ovate-lanceolate, sessile, entire, acute, base obtuse to rounded or somewhat cordate, somewhat clasping the stems, 1.5 to 4 cm long, the upper much smaller than the lower ones. Branches few, scattered, up to 18 cm long. Heads corymbose-paniculate, 6 to 7 mm long, pedicellate, the outer bracts small, few, 2 mm long or less, the inner narrowly oblong, obtuse, 5 to 6 mm long, about 1 mm wide, glabrous. Flowers few, about 10 in each head. Corolla

about 4 mm long, the tube 1 mm. Achenes 3 to 3.5 mm long, somewhat compressed, glabrous, longitudinally about 9-ribbed, slightly narrowed upward. Pappus nearly white, 2.5 mm long, rather copious. Torus glabrous.

LUZON, Tayabas Province, Dingalan, *Bur. Sci. 26586 Ramos & Edaño*, August 24, 1916, on rocks along the seashore.

A characteristic species, among the Philippine forms most closely allied to *Lactuca dentata* C. B. Rob., but entirely different from that species. It is readily recognizable by its heteromorphous entire leaves. The specimens were originally identified as *Lactuca stolonifera* (A. Gray) Maxim., but a comparison made by Mr. S. F. Blake with Gray's type shows it to be very different from that species.

BELTRAN. FELIXFERTO

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JANETOSPHAERA, A NEW GENUS, AND TWO NEW SPECIES OF VOLVOX

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FIVE PLATES AND FIVE TEXT FIGURES

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INTRODUCTION

There have been recognized, hitherto, four species of *Volvox* that have their cells connected by protoplasmic strands. Two of these, *V. globator* (L.) Ehrenberg and *V. aureus* Ehrenberg, have long been known, and have been the subjects of detailed study by several investigators, chiefly in Europe, with results which were summarized in the papers of Klein ('89A and '90) and of Janet ('12). The two others have been described more recently; *V. perglobator* Powers ('08) from North America and *V. rousseleti* West ('10 and '18) from Africa.

The two older species are readily distinguishable from one another by the form of the vegetative cells and by the character of the outer wall of the oospore. *Volvox aureus* has cells which are round in surface view and connected by protoplasmic filaments as slender as the cilia, and the outer wall of the oospore

is smooth; while the cells of *V. globator* are angular in surface view and connected by relatively stout protoplasmic processes, and the outer wall of the oospore is verrucose with conical warts (West, '10). A more fundamental difference between these species was demonstrated by Meyer ('96) in his investigation of the structure of the membranes of these organisms; a difference so great, in my estimation, as to warrant the separation of *V. aureus* from *Volvox,* which I now propose, under the name **Janetosphaera** genus novum, based on Meyer's text figs. 3 and 4 (reproduced herewith as text figs. 1 and 2) of the cell membranes as compared with his text figs. 1 and 2 (reproduced herewith as text figs. 3 and 4) of the corresponding structures of *V. globator.* For a clear recognition of the true status of *J. aurea* (Ehrenberg) Shaw it is desirable that membrane studies as detailed as those of Meyer be made to cover all phases of the life histories of these and other species of the larger Volvocaceae. Some specimens collected at Stanford University, California, in 1896, and still in my possession, will be described in this paper. They present the characters given by Klein ('89A) and by Overton ('89) for this species, and testify to its occurrence in western North America.

Of the newer species, *V. perglobator* (Powers '08) has vegetative cells very similar to those of *V. globator,* from which it is distinguishable by having a larger number of oospores, which often exceed 100 as compared with a range of from 12 to 40, and by having the outer wall of the oospore crenate. *Volvox rousseleti* (West '10 and '18) is readily separable from *V. globator* by the greater number of cells, 25,000 to 50,000; by the constant number of gonidia, 8; by the larger number of oospores, 120 to 150; and by the dense covering of spines on the spores. For *V. perglobator* no estimate of the number of cells is given by Powers, so we are left to assume that its range of variation in this respect is similar to that of *V. globator.*

In the vicinity of Manila, during the latter months of the rainy seasons of 1914 and 1915, I made collections which included several species of the higher Volvocaceae. Some of these have vegetative cells without protoplasmic connections, and display developmental characters which make it very questionable whether any of these organisms lacking the protoplasmic connecting strands between their cells should be regarded as species of the genus *Volvox.* They have been or are being described in other papers. Others, the subjects of this paper, do have protoplasmic connections between their cells.

For one of these which most nearly fits the description of *V. perglobator* (Powers, '08), but is readily distinguishable from it by having the outer wall of the oospore echinate, I propose the name **Volvox merrilli**, dedicating the species to Prof. Elmer Drew Merrill, who has been intimately associated with the locality in which this species was first collected, Pasay, on the southern outskirts of Manila, near Manila Bay.

The other new species has smaller, more or less pear-shaped vegetative cells and smaller oospores. For this the name **Volvox barberi** will be used, the species having been first collected by Dr. Marshall A. Barber, at Pasig, a few kilometers east of Manila. Collecting places which Doctor Barber reported at Pasig yielded three new genera of the Volvocaceae, four new species, and a total of at least six species in a great variety of life phases.

Descriptions of the two older species of *Volvox* (one under its new name), drawn only partly from material in hand, will now be given. These will be followed by transcripts of the descriptions of the species described by others that are considered by me to be properly retained in the genus *Volvox*, and then by descriptions of the new species.

Genus JANETOSPHAERA novum

(*Volvocaceae, Volvoceae*)

Type species, *Volvox aureus* Ehrenberg, fide Meyer.

Body a free-swimming hollow spheroidal coenobium of biciliate cells that contain chloroplasts. The cells appear to be in the periphery of a gelatinous matrix surrounded by a hyaline envelope. Protoplasts globose or ovoid in form, inclosed in thick membranes and partially separated by middle lamellae that extend as fibrils to near the center of the coenobium. Protoplasts connected by protoplasmic strands about as slender as the cilia. Asexual reproduction by gonidia that are differentiated late in the development of the soma or coenobium. Sexual reproduction by antheridia that produce spermatozoids, each of which has two cilia borne on the anterior end, and by oogonia that produce each a single egg.

The character of this species as summarized by Klein ('90, pp. 84 to 86) will be restated in the following paragraphs, and are, for the most part, probably drawn from one and the same species; though, as will be pointed out farther on, some were probably taken from very different species.

JANETOSPHAERA AUREA (Ehrenberg) comb. nov.

Volvox aureus Ehrenberg 1831 (fide Cohn).
Volvox globator Ehrenberg *ex parte* (fide Klein).
Volvox minor Stein 1854.
Volvox dioicus Cohn 1875.

Mature coenobia very variable in size according to habitat, and even in the same locality quite variable; 170 to 850 μ; coenobia of more than 500 μ forming only a small fraction of all.

Somatic cells average from 500 to 1,000, minimum about 200, maximum about 4,400.[1] Sexual coenobia mostly with more numerous cells than asexual coenobia of the same size.

Somatic protoplasts 5 to 8 or sometimes 9 μ in diameter, round, not crowded; chromatophores not extending into the connecting filaments; connecting filaments very slender, of about the same thickness as the cilia and sometimes in pairs or even threes between the same neighboring protoplasts.

Gonidia round like the somatic cells,[2] about 20 to 30 μ before the first division; connected with neighboring protoplasts by numerous protoplasmic filaments. Number of gonidia ranging according to habitat from 1 to 16, mostly 4 to 8 or 6 to 10. Bending to form the hollow sphere is already present in the 4-celled stage; gonidia with development arrested in early stages occur only occasionally.

Daughter coenobia reaching 200 to 250 μ (sometimes 300 to 350 μ) diameter before birth. Protoplasts at this time already rounded and always separated from one another by gelatinization of the cell membranes. Gonidia and androgonidia frequently more or less advanced in development at this time.

Distinction between asexual and sexual coenobia not sharply maintained. Among asexual and sexual coenobia are coenobia

[1] Zimmermann ('21, p. 260) gives the cell numbers in material collected by him in the vicinity of Freiburg in Brunswick, Germany, in the spring of 1919 as mostly fairly uniformly 1,024. In rare cases he found 2,048-celled coenobia. In cultures that were deteriorating the cell numbers fell to as low as 256. These numbers are based on his opinion that in the development of the coenobia all the cells of the embryo formed from the gonidium undergo the same number of divisions. This should dispose of the assertion of some of the earlier authors, Goebel ('82), and Goroschankin ('75), repeated by Oltmanns ('04) that the four cells forming the anterior polar group in the 16-cell stage do not undergo further division.

[2] Zimmermann ('21, p. 262) has shown that the gonidia are not differentiated from the somatic cells until after the last cell division by which the full number of cells of the coenobium is produced.

with all possible intermediate combinations of reproductive bodies; antheridia and daughter coenobia, oogonia and daughter coenobia, and finally antheridia, oogonia, and daughter coenobia in the same mother coenobium.

The sexual coenobia are more commonly dioecious, but also monoecious, and then usually proterogynous, though rarely proterandrous or with both sexual elements maturing at the same time.

The male coenobia, the so-called "Sphaerosira," (when maturing within the mother coenobia, called "Endosphaerosira") bear very numerous androgonidia, the number averaging between 300 and 500, though sometimes as great as 1,100.

Androgonidia round like the somatic cells, 9 to 12.5 μ in diameter before segmentation, connected with each neighboring protoplast by only one, two, or at most three connecting filaments; formed from about one-third of all the cells of the male coenobia; numbers in combination with other reproductive bodies at most 12 to about 24.

Antheridia usually in the form of platelets 12 to 18 μ wide with at most 32, though less often 16 or only 8, spermatozoids.[8] More than 32 spermatozoids in an antheridium is exceptional. In some cases antheridia form hollow spheres of spermatozoids. These may reach diameters of 30 to 48 μ, and contain many more sperms than do the platelets.

The spermatozoids are 8.5 to 12.5 μ long and 2 to 3 μ thick; the chloroplast is clearly leaf green; the nucleus is roundish and contains a nucleolus; the cilia are terminal on the end of a short colorless beak at the base of which are two contractile vacuoles and a stigma. The antheridia discharge the platelets or globoids into the water before the spermatozoids separate.

[8] Zimmermann ('21, p. 270) determined that the number of chromosomes in the nuclei is the same in all stages of the antheridium as in the vegetative development of the coenobia. In the 16-cell stage of the coenobia developing from oospores he counted the same number, thus establishing that, though the zygotes are diploid with respect to the chromosome number, the coenobia are haploid. Zimmermann also found that in the sixteen or thirty-two cells of the slightly cupped platelet of spermatogenous cells the nuclei do not migrate from the concave to the convex side of the platelet, as in the newly developed coenobia, but remain at the ends of the cells forming the concave surface of the platelet. In this respect it is to be expected that the species of *Volvox* having globoid antheridia will be found to differ from *Janetosphaera*, and it may be that the difference will be found to extend to those antheridia of *Volvox* that form platelets of sperms.

The oogonidia occur in numbers ranging from 1 to 15 like the gonidia, though mostly 3 to 8, and more seldom 6 to 10.

The oospores are spherical, with two somewhat eccentric smooth membranes. They are brownish red (orange red in glycerine), and measure 60 to 65 or even 70 μ in diameter.

In regard to the foregoing synopsis of the characters of *Janetosphaera aurea* (Ehrenberg) Shaw, as stated by Klein ('90) under the name of *Volvox aureus* Ehrenberg, it is to be remarked that incorporated therein are characters drawn from material wrongly identified by Klein as of this species. The material collected by Doctor Migula at Karlsruhe and described by Klein ('89A, figs. 1 to 8) under this name appears clearly from the figures to be at most a variety of *Volvox carteri* Stein. The latter is so different from the earlier described species of *Volvox* that it has been made the type of another genus, *Merrillosphaera* (Shaw '19, p. 512, footnote), described in another paper. Possibly still other species contributed some of the material to the make-up of this composite synopsis. The preparation of a true statement of the characters of *Janetosphaera aurea* is a task for someone familiar with the species in its European habitat and one to be undertaken with the related species and genera that have been found in other quarters of the globe in mind.

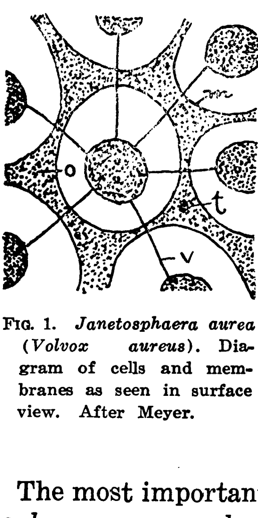

FIG. 1. *Janetosphaera aurea* (*Volvox aureus*). Diagram of cells and membranes as seen in surface view. After Meyer.

The most important addition made to our knowledge of *Janetosphaera aurea* subsequent to the accounts of Klein ('89 and '90) and Overton ('89) is the description by Meyer ('96) of the cell membranes of the somatic cells. According to this account each somatic protoplast is surrounded by a thick gelatinous wall that is separated from that of the neighboring protoplasts by a firmer middle lamella (text figs. 1 and 2, *m* and *m'*). Continuous with this middle lamella there is a cuticular covering that bounds the gelatinous membrane on the outer side. This is united with a common cuticular membrane, *p*, covering the coenobium. But on the side of each cell toward the center of the coenobium there is no firmer limiting membrane near the protoplast. The intercellular middle lamella, *m'*, is simply attenuated toward the center of the coenobium and extends far in that direction, the lamellae of different ages being attenuated

and extended to different degrees. So each protoplast is not inclosed in a little lamellar box of its own, as in *Volvox globator,* but occupies one of a layer of peripheral stalls each of which opens toward the interior of the coenobium into a segment of the central space that is shared by a number of protoplasts together.

JANETOSPHAERA FROM CALIFORNIA

My personal knowledge of *Janetosphaera aurea* is limited to that obtained from observations on two preparations in glycerine of material collected and mounted by myself at Stanford University, California, North America, in April, 1896. The material had been fixed and stained in picro-nigrosin and mounted under cover glasses that were then sealed to the slides by rings of Brunswick black. The staining had been very light, and the glycerine in which the specimens were mounted was slightly tinged with picric acid. After eighteen years the specimens, in 1914, as previously noted (Shaw, '19, p. 514), were in good condition; but the cement had become cracked and loosened to such an extent that it seemed advisable to remount the material. Before this was done some notes were taken that will serve as the source of the following descriptive data pertaining to *Janetosphaera aurea* found in California.

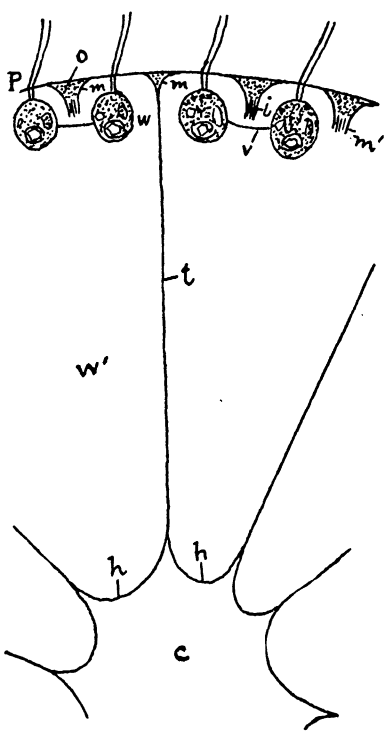

FIG. 2. *Janetosphaera aurea* (*Volvox aureus*). Diagram of cells and membranes as seen in cross section of coenobium. After Meyer.

The material in question consisted of twenty-five asexual coenobia on one slide and thirty-nine sexual and three asexual coenobia on the other.

Measurements made of coenobia were: Asexual, 300 by 330 μ and 320 by 330 μ; sexual, 400 by 425 μ and 640 by 700 μ. Estimates of the numbers of cells in these coenobia gave, in round numbers, respectively, 1,200, 1,800, 2,600, and 8,600 These estimates were made by counting the cells in areas 90 μ square under a square-ruled eyepiece micrometer and making

the calculation as described in an earlier paper (Shaw, '18, p. 256).

The somatic protoplasts are ovoid and have slender connecting filaments such as have been shown in the high-power drawings of Klein ('89 A, figs. 5 and 26), Overton ('89, fig. 1), Meyer ('96, pl. 8, fig. B), and Janet ('12, fig. 4). Measurements of average protoplasts in the four coenobia above noted gave 7 to 8 μ in the first and 5 μ in the others.

The somatic protoplasts are farther apart about the anterior pole and closer together about the posterior pole than they are in the equatorial region. The distances between the protoplasts in the first coenobium are about one and a half to two protoplast diameters forward and one-half to one protoplast diameter aft.

The number of connecting strands between neighboring protoplasts in the first coenobium was noted to be one, two, and three, and in the second coenobium mostly one, and in a few cases two. It was also noted that strands from somatic to reproductive protoplasts were visible, but they were not counted.

The asexual reproductive bodies in 25 asexual coenobia and the female reproductive bodies in 39 sexual coenobia were counted and found to be distributed as follows:

4,	5,	6,	7,	8,	9,	10,	11,	and	12	reproductive bodies in
3,	4,	10,	5,	2,	1,	0,	0,	and	0	asexual coenobia and
2,	6,	5,	13,	5,	3,	2,	2,	and	1	female coenobia, respectively.

Thus the number of gonidia in this material ranges from four to nine and is most commonly six. Likewise the number of oogonidia ranges from four to twelve and is most commonly seven.

Daughter coenobia in one mother were measured. Of four daughters, two in the 16-cell stage measured about 36 μ and two in about the 64-cell stage measured about 54 μ in diameter. Another coenobium contains seven reproductive cells (and one or possibly two vacant sites of such cells) that are ovoid—six measuring 40 by 45 μ and one 25 by 35 μ. In the nearer hemisphere of this coenobium two cells larger than the somatic cells (10 μ in diameter) are visible. They are located about three or four cells distant from the nearest reproductive cells.

Oospores counted and measured in one coenobium were seven, with diameters of the zygote protoplasts 53 to 57 μ and of the outer spore wall 67 to 73 μ. In the largest coenobium there were ten oospores, their protoplasts being about 60 μ and their

outer wall about 79 μ in diameter. The spore walls are smooth, and the zygote protoplasts are eccentric within them. These are immature spores.

Mature oospores have, in addition to the spherical smooth outer wall, a much smaller spherical smooth inner wall that is eccentric and in contact with the outer wall on one side. The specimens are now under slight pressure of the cover glass and the spores may be slightly flattened and widened. In one of the mature oospores the outer wall measures 75 μ in diameter, the inner wall 62 μ, and the protoplast 57 μ.

VOLVOX Linnaeus

(*Volvocaceae, Volvoceae*)

Type species, *Volvox globator* (L.) Ehrenberg.

Characters which serve to distinguish the species properly included in this genus from species that should have places in other genera are embraced in the following diagnosis:

Globose, free-swimming bodies, consisting of very numerous biciliate cells forming a peripheral layer; the protoplasts more or less star-shaped and covered with thickened walls through which neighboring protoplasts are connected by stout protoplasmic processes; each cell containing a green chloroplast. The cell membrane typically with a firmer lamella cutting off the cell from the interior of the body.

The descriptive diagnosis of the type species as given by Klein has been transcribed in the following paragraphs.

VOLVOX GLOBATOR (L.) Ehrenberg (fide Klein, '90, pp. 82–84).

Volvox stellatus Ehrenberg 1831.
Volvox monoicus Cohn 1875.

Coenobia usually somewhat elongated, seldom exactly spherical; diameter mostly 600 to 800 μ, occasionally ranging from 400 to 1,200 μ.

Somatic cells mostly about 10,000; ranging from 1,500 to 22,000.

Somatic protoplasts 2 to 7.5 μ, usually 3 to 5 μ, irregularly star- or amoeba-shaped, mostly somewhat crowded; chloroplast extending into the cytoplasmic processes, which are almost always simple and usually, even when the chloroplast processes are withdrawn, considerably thicker than the cilia.

Gonidia of the same form (amoeba-shaped) as the somatic cells, becoming 15 to 18 μ in diameter before the first division, connected with the neighboring somatic cells only by single pro-

toplasmic connecting filaments; almost always only eight divide, seldom more (though occasionally as many as 14) and more seldom less. Bending to the hollow sphere begins mostly in the 8-celled stage. Besides these there occur in the asexual coenobia not infrequently a larger number (10 to 30) of undivided or once-divided gonidia which do not develop further.

The daughter coenobia reach at time of birth mostly a size of 150 to 200 μ (very seldom more, though sometimes as much as 320 μ); at this time the somatic cells are hexagonal from mutual pressure, the cell membranes not thickened, and the gonidia and androgonidia are not yet fully developed and still undivided.

The sexual coenobia are normally always monoecious and usually proterandrous, though sometimes the eggs and spermatozoids mature simultaneously in the same coenobium.

The androgonidia have the amoeboid form of the gonidia and nearly the same size, reaching about 15 μ; their number is somewhat variable, usually about five become functional, though sometimes as few as one or as many as fifteen.

The antheridia are platelets or hollow spheres of numerous spermatozoids, seldom less than 100, often very many more. Diameter of the antheridial sperm bundles 23 to 34 μ [according to Cohn ('75, p. 18) 35 to 44 μ].

Spermatozoids 5 to 6 μ long with pale green or yellowish chloroplast; a very long colorless beak at the base of which two long cilia are inserted near the stigma and the two contractile vacuoles. Rarely the cilia are borne on the end of the beak. The nucleus is rod-shaped (Overton, '89, p. 30) and without a nucleolus.

The sperm bundles and spheres partly break up within the mother coenobium and partly are discharged into the water where the constituent spermatozoids separate.

The gynogonidia early become rounded off and reach a size of 44 to 50 or even 56 μ. They number 20 to 64, mostly about 30. The oospore has a smooth inner membrane and a stellate prickly outer membrane. When ripe they are brownish red (in glycerine clear orange red).

To the foregoing synopsis of the characters of *Volvox globator* Ehrenberg, as stated by Klein ('90), two features that have been brought to light more recently may be here appended.

The oospore has been found by Janet ('14, p. 6, fig. 1) to consist of a large zygote inclosed in a thin spherical follicle formed of a

layer of atrophied cells,[4] this being surrounded in turn by inner and outer spore walls. The atrophied cells he regards as somatic cells of a dwarf female coenobium of which the gynogonidium proper is the single reproductive cell.

The cell membranes of the somatic cells, first adequately described by Meyer ('96) were diagrammatically shown in elaborate figures by Janet ('12, figs. 1, 2, 3, and 6) in his comprehensive monograph on *Volvox*. According to Meyer's account, illustrated by his diagrammatic figures that are reproduced here as text figs. 3 and 4, the cells of *Volvox globator* are short prismatic, 6-sided as seen in surface view (fig. 4) and rectangular as seen in a section normal to the surface of the coenobium (fig. 3). A fine, relatively thick membrane lamella, *m*, that he called the

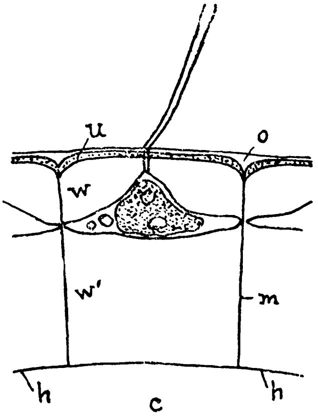

FIG. 3. *Volvox globator*. Diagram of cell membranes as seen in a cross-section view of a portion of the coenobium wall. After Meyer.

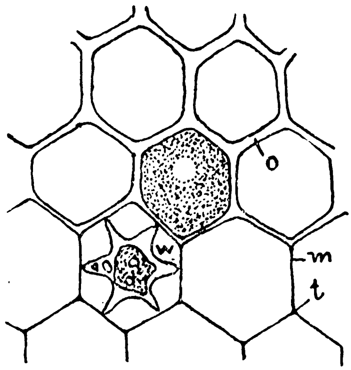

FIG. 4. *Volvox globator*. Diagram of cell membranes as seen in surface view and tangential sections of the coenobium wall. After Meyer.

"Hülllamella," unites the cells. The peripheral lamella, *p*, forming the outer boundary of the coenobium, is relatively thick. The lamella, *h*, bounding the cell toward the interior of the coenobium is of the same thickness as the lateral part of the lamella, *m*. The space between the "Hülllamella" and the pro-

[4] Unfortunately Janet's preliminary note on the egg of *Volvox globator* was overlooked by Zimmermann ('21) at the time of the preparation of his most valuable paper on the development and cytology of *Volvox*, and the latter gives no account of the development of the oogonidium of this species. So we still await detailed confirmation of Janet's account of the oogonidial follicle. Although nothing like this follicle was found by Zimmermann in the investigation of his material of *Janetosphaera aurea*, making it appear that the absence of such a follicle constitutes a difference between these genera, still the results will be more conclusive when we have a definite report on the subject made with this point in mind.

toplast is filled with a jelly, *w* and *w'*. Between the peripheral lamella, *o*, and the jelly, *w*, there is a soft mass, *u*, that differs somewhat from the jelly. The "Hülllamella" and the jelly together were regarded by Meyer as constituting the cell wall and directly comparable with the cellulose walls of the higher plants. The gelatinous layer of the membrane contains canals that are filled by extensions of the protoplast so that the protoplast is star-shaped. According to Meyer the cavity of the coenobium within the layer of cells is occupied by a watery liquid. Janet ('12, p. 34) found the interior of the coenobium to be filled with a jelly made up of radial columns, one extending to near the center from each of the peripheral cells of the coenobium.

VOLVOX PERGLOBATOR Powers.

This species was described by Powers ('08) from shallow pools in the neighborhood of Lincoln, Nebraska, North America. In his paper dealing with the subject he reported it also from the following North American localities: Rocheport, Missouri; St. Louis, Missouri; New Orleans, Louisiana; the vicinity of Ann Arbor, Michigan; and the neighborhood of Sebago Lake, Maine. He also reported that material he had seen from the states of Washington and Massachusetts probably belonged to the same species. The description was without illustrations.

The form of the coenobium was not stated except for the large female coenobia, which were called oval by Powers. The size reached more than 1,000 μ in some of the asexual coenobia of each of Powers's collections, while coenobia of 1,200 to 1,400 μ were readily obtainable, and one old furrowed coenobium of 1,600 μ was measured. Many of the female coenobia from the same source as the largest asexual coenobium were about 1,000 μ in diameter and sometimes larger than this in the longer dimension.

The number of somatic cells was not given, though they were characterized as excessively numerous. The characters of these cells were stated to coincide closely with those of *Volvox globator*. They were called highly stellate and reported to duplicate the figures by Overton ('89) and Meyer ('96) of the somatic cells of that species. In the oldest sexual coenobia the somatic protoplasts became widely separated from one another and their cytoplasmic processes extended in irregular bent lines until the cell bodies were hardly noticeable and the somatic layer pre-

sented the appearance, under a moderate magnification, of a spongelike reticulum. Powers was able to observe perfectly the extremely delicate connecting fibrils such as Meyer had found to form connections between the cytoplasmic processes of neighboring protoplasts.

In some instances pairs of neighboring somatic cells were found with protoplasmic processes that quite penetrated the cell membranes and united the protoplasts by a bridge of cytoplasm that was little narrower than the diameters of the protoplasts. These would seem to be cases in which the cell divisions had never been normally completed.

In regard to the gonidia and the development of the asexually produced coenobia no particulars were given.

The sexual coenobia were dioecious, the separation of the sexes being uniform. Among thousands of coenobia Powers found but a single exceptional instance. That was an enormous female coenobium loaded with oospores which showed on one side a single well-developed antheridium, while near it a vacant space was evidence of the discharge of the contents of another. The combination of oogonidia or androgonidia in the same coenobium with gonidia is in this species only an anomaly. Powers saw but three such coenobia.

The oogonidia were produced in large numbers, often exceeding 100 in poorly developed material, while in the material first obtained there were not infrequently between 300 and 400. Powers believed that counts would show considerably higher numbers. There was a small area of purely somatic cells about the anterior pole of the female coenobium. The oospores were described as crenate zygotes.

The male coenobia varied greatly in size, number, and manner of development. Sometimes they developed all their antheridia nearly simultaneously, at other times their development was spread over a considerable period, nearly all stages being present at one time. Old coenobia were found that were almost devoid of androgonidia or antheridia, all or nearly all of the spermatozoids having been discharged. In most of the coenobia the number of antheridia was very high, there being usually from fifty to one hundred fifty androgonidia or antheridia in one coenobium.

The antheridia are hollow, globular bodies, strangely like a minute coenobium. As the sperm cells become developed into spermatozoids the globular body becomes much flattened, re-

taining, however, its cavity and showing spermatozoids with cilia directed outward on all sides. These cilia do not project similarly from all of the spermatozoids; one side, even while the globoid is still within its parental lodgment, always shows the cilia radiating from a center; toward the periphery they bend around the sides and extend straight backward, as do all those on what may be called the posterior side.[5] The sperm masses seem always to escape outward into the surrounding water, never into the interior of the coenobium. Among material rich in male coenobia these groups of sperms were readily found, swimming with vigorous independence among the various coenobia. The locomotion of the sperm globoids is by a rapid spiral rotary movement with one pole habitually directed foremost.

The number of sperms in a globoid was not estimated, though it was thought to be twice as great as the maximum number that had been given previously for the sperm platelets of any species. The sperm globoids were subject to some variation. In material from climates less sunny than that of Nebraska, as Maine and Michigan, the globoids do not always become complete. The form is the same, but a small round opening remains on one side.

The spermatozoids, Powers stated, are shorter and smaller than any he had seen before.

Photomicrographic figures used by Harper ('18) to illustrate his paper on binary fission in *Volvox* all appear to represent a true *Volvox* rather than a *Janetosphaera.* They show stages in the segmentation of the gonidia. It may be that these are the only figures yet published that show anything of *Volvox perglobator.*

VOLVOX ROUSSELETI West.

This species was based on asexual coenobia collected from a pool near the station at Gwaai in Rhodesia, Africa, by C. F. Rousselet, in September, 1905. The description by West ('10) is illustrated by photomicrographic figures of young and old coenobia and of a group of somatic cells. West ('18) supplemented the original description by giving an account of sexual and mixed coenobia that were found in material collected by A. W. Jakubski, on his trip of 1909–10, in the Ussangu Desert,

[5] The posterior side is probably the region about the site of the phialopore.

in what was then German East Africa. These were illustrated by photomicrographic figures of two male, one mixed (male and asexual), and one female coenobium, the latter containing mature oospores, and by a drawing of a ripe oospore.

The adult coenobia were described as large and globose, measuring 1,125 to 1,240 μ in diameter. The figures show the mixed and male coenobia (West, '18) as somewhat elongated, and give measurements of 1,090 to 1,240 μ in width and 1,340 to 1,400 μ in length. The number of cells was stated to vary from about 25,000 to rather more than 50,000. Estimates of the cells shown in the figures of male and mixed coenobia range between 32,000 and 35,000. The protoplasts of the somatic cell are 4 to 6.5 μ in diameter. In surface view they are somewhat angular and appear to possess relatively stout protoplasmic processes connecting them with their neighbors. The spaces between neighboring protoplasts are narrower than the breadths of the protoplasts. Thus there is a dense crowding of the protoplasts that gives the coenobia a very robust appearance.

The number of gonidia formed in a coenobium was regularly eight. From the micrographic figures showing daughters, it appears that the gonidia are very regularly and symmetrically arranged; four are equidistant in a transverse plane through or very slightly in advance of the equator, and the four others alternate with the first four in a transverse plane midway between the equator and the posterior pole.

The daughter coenobia were set free when each had a diameter of about 370 μ. At this stage the protoplasts apparently touched one another, and they continued to do so almost up to the time when the coenobia reached a diameter of 800 to 850 μ. The first formation of daughter coenobia was observed in mother coenobia of that size. From this it appears that the gonidia are not differentiated in size from the somatic cells until some considerable time after the birth of the coenobia in which they are formed.

The oogonia and androgonidia are produced in different coenobia, though gonidia and androgonidia occur in the same coenobium (West, '18, fig. 2).

The number of oogonidia or oospores in a coenobium was stated to range from 120 to 150 and to average 128. The figure (West, '18, fig. 8) shows them to be absent about the anterior pole.

The oospores are shown and described as densely clothed with strong conical spines. Their average diameter without the spines is given as 44 μ and the length of the spines 11 to 12 μ.

The androgonidia are described as very numerous in each male coenobium; usually there are several hundred. They are absent about the anterior pole. The antheridia, though shown in the photomicrographs of three coenobia (West, '18, figs. 1, 2, and 7) on a scale of 50 diameters, were not described. Presumably they were regarded as so similar to the antheridia of the European species of *Volvox* as not to call for particular description. This is unfortunate, because of the considerable variation in the antheridia in the species of *Volvox* from other parts of the world. The spermatozoids, naturally, were not described, the material having been preserved in formalin.

VOLVOX MERRILLI sp. nov.

For the type of this species the specimen represented by Plate 1, figs. 1, 2, and 3, and Plate 2, fig. 4, has been selected. The specimen appears to have been fixed in a picro-nigrosin solution, which stained it lightly, and to have been mounted with others from the same collection under a sealed cover in glycerine, concentrated from a 10 per cent solution by evaporation. The mounting fluid is strongly tinged with picric acid.

The upper and lower sides of the specimen as mounted require a difference in focal adjustment of about 300 μ as indicated by a Zeiss side-focus fine adjustment. Assuming a refractive index of 1.4 for the mounting medium, I estimate the thickness of the specimen at about 420 μ. The short and long diameters of the coenobium measure about 690 and 750 μ, respectively. By a camera lucida sketch method described in another paper (Shaw, '18, p. 256) from a count of 62 cells in an area of 8,100 sq. μ the number of cells in the specimen was estimated to be about 12,100. The spacing of the somatic cells is fairly uniform for any particular part of the colony, and they lie in tolerably regular rows of various curvatures. The average distance between the centers of the cells of this specimen is about 11 μ in the equatorial region, about 18 μ around the anterior pole, and very little less than 11 μ near the posterior pole.

The protoplasts are roundish, unequally angular, about 4 μ in diameter. (In immature sexual coenobia the protoplasts measure 6 to 7 μ.) Their outer ends are between 1 and 2 μ from the outer limiting membrane of the colony. Their protoplasmic processes proceed from below the middle of each. The outer surface of the colony is nearly smooth, though very slightly wavy about the anterior pole. No inner limiting mem-

brane (toward the center of the coenobium) of the somatic cells is visible in the specimen. The connecting filaments mostly show a pair of nodes near their middles. There is but one direct filament between any two neighboring protoplasts, but some protoplasts send out one filament to a neighbor and another to a filament connecting that neighbor with a third protoplast, and others send out two filaments which unite with two processes connecting the same neighbor with two other protoplasts.

The oospores in this specimen were all sketched in outline with a camera lucida and counted. The number is 92. There are none in the anterior fourth or fifth of the colony. They all lie near the periphery of the colony, 29 to 39 μ below the outer membrane. They are fairly evenly distributed in the area which they occupy, though showing considerable grouping in pairs, and leaving vacancies at what I suppose to be the sites of antheridia, of which there are about three on the upper and the same number on the lower side.

The outer wall of the spore is developed into hollow spines, of which peripheral counts in the median optical section give from 14 to 16, averaging 15, a number which corresponds to a total of about 82 on the spherical surface. These spines are nearly 11 μ high, and their bases are close together. The basal two-fifths of each spine is broadly conical, most of the remainder is more narrowly conical with a tip which is more broadly conical. Many of the spines are somewhat inclined to one side. The thickness of the wall of the spines does not show clearly with the highest power that can safely be applied, but this wall does not seem to be thick. It has a brownish yellow color. The diameters of the spores measured between tips of spines are about 60 μ, between bases of spines about 40 μ.

The oospores measure in diameter 30 to 32 μ, averaging 31 μ. The protoplasm is densely granular and yellowish. Within it there is a dark red spherical body which seems to be the nucleus. It may have been stained with some stain the use of which was not recorded. Its diameter is a little more than two-fifths that of the protoplasts, and it is located excentrically about one-fifth of the protoplast diameter from one side. Close beside this red body there is a clear space or transparent body about half as thick as long, its length being a little less than the diameter of the red body. It lies somewhat nearer to the periphery of the protoplasts than does the red body.

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More or less directly over each oospore, seen in surface view of the colony, there is a vacancy in the layer of somatic cells, the site of the cell before it became the egg or egg apparatus. There are other, larger vacancies, as before mentioned, of which two show plainly in the photograph (Plate 1, fig. 1), that are supposed to mark the sites of antheridia. A few cells here and there in the somatic layer are larger, having diameters two or three times as great as the average for somatic cells.

The specimen is in good condition, the greatest damage it has suffered being a crease or furrow formed on the right side, from the equator forward halfway to the anterior pole, by a grain of sand which lies in the deeper end of the furrow.

The material from which this specimen was taken was collected from a seasonal pool (carabao wallow) about 5 meters in diameter and 80 centimeters deep, without inlet or outlet, in a grassy field in Pasay, about 1 kilometer south of Manila, September 16, 1914. At the time the pool was about half emptied by evaporation and seepage. The pool was designated by the letter A for the purpose of labeling the material taken from it on this and later dates.[6]

In several mature female coenobia on the same slide with the type specimen there is occasionally a smaller oospore among the others. One such is shown in Plate 2, fig. 5. This is from a coenobium containing 77 oospores. The large oospores measure about 42 μ, exclusive of the spines, and the spines are about 11 μ high. The spores measure about 64 μ over all. The small spore measures about 37 μ, without the spines, the spines are about 6.5 μ high, and the width of the spores over all is about 50 μ. The wall and the spines of this small spore are thinner and the spines less crowded than on the larger spores. The walls of these small spores resemble those of the next species to be described.

The numbers of oospores counted in some of the coenobia on the same slide with the type specimen were: 129, 92, 90, 77, 67, 60, 57, 47, and 38, the larger numbers being in larger coenobia and the smaller numbers in smaller ones.

[6] The slides bearing the type specimens of this and of the other Philippine species of *Volvox* are in my possession. Slide mounts of material from the same collections have been sent to Prof. Frank G. Haughwout, Bureau of Science, Manila, and to Prof. Douglas H. Campbell, Stanford University, California. Material from the type locality, bottled in glycerine, has been sent to sixteen biologists in North America and to sixteen in Europe and Asia. Duplicates of this bottled material are available for distribution from my American address; Claremont, California.—W. R. S.

No very mature asexual coenobia were found in this lot of material. Several were at about the stage represented by the one shown in Plate 3, fig. 11. This coenobium contains about 17,800 cells, with protoplasts of about 6 to 8 μ diameter, and seven embryo daughters of about 80 μ diameter. Four of these daughters are about in the equatorial plane of the coenobium and the others near the hinder pole. Another similar asexual coenobium has eight daughters, of which four near the equatorial plane are about 80 μ, two on one side near the hinder pole about 65 μ, and two on the other side near the hinder pole about 30 μ. Still another similar asexual coenobium, one with about 20,000 cells, has four daughters of about 73 μ near the equatorial plane, and four alternating with them nearer the hinder pole that measure 45 to 59 μ.

Smaller coenobia with fewer daughters are represented by the one shown in Plate 3, fig. 7. This measured about 360 by 390 μ, had about 5,000 cells, and contained two embryo daughters of about 46 μ diameter.

A much smaller one is shown in Plate 3, fig. 10. This one measured about 200 μ in diameter, had about 1,145 cells, and contained three embryos of about 27 μ diameter in about the 8-celled stage.

One from a different lot of material is shown in Plate 3, fig. 8. This is about 285 by 300 μ, has about 2,400 cells, and contains eight reproductive bodies that are from two to five times the diameter of the somatic cells.

Young coenobia of the species are very numerous on the slides of the type material and in other collections. Two such young coenobia are shown in Plate 3, figs. 6 and 9. The preparation from which these were photographed has dried up. But they may be fairly well described from the photographs. The older of the two is certainly a sexual coenobium, and the younger is probably also. The younger (fig. 6) measures about 530 by 540 μ and has about 18,000 cells. In it can be seen a sperm globoid in an advanced stage of development, an androgonidium divided into four cells, and another divided into two. The oogonidia are not yet differentiated. The older (fig. 9) measures about 490 by 550 μ and has about 9,500 cells. In it can be seen two sperm spheres in different stages of development, and numerous scattered cells of about twice the diameter of the somatic cells. These must be oogonidia.

Coenobia with both asexual and sexual reproductive bodies were observed among the material from pond A. One of this

kind has four embryo daughters distributed symmetrically about the hinder pole and dominating the hinder two-fifths of the coenobium. The forward fifth is without reproductive bodies and in the remaining two-fifths or less are oogonidia that form a zone around the coenobium. The oogonia are more advanced in development on the forward side of the zone, and more backward toward the hinder side of the zone. Among the oogonia are the sites of six or more antheridia that are marked by empty places. In another mixed coenobium with four daughters the zones of sexual and asexual bodies are not so far separated. In still another there is present also, among the oogonia, a rather large sperm globoid. In one case there are two daughters with a small number of oogonia, and in another two daughters with a rather large number of oogonia. In a similar lot of material there are two cases of coenobia with a group of five embryo daughters and a zone of oogonia. In one of these the zone of oogonia is narrower on one side.

It appears from consideration of the aforementioned cases that in this species the asexual and sexual reproductive bodies are typically formed in separate coenobia; also, that the male and female bodies are formed in the same coenobia, the former maturing first; and, further, that when occasionally sexual and asexual bodies are formed in the same coenobium they are distributed as if in different segments of the coenobium. In the cases described the asexual bodies are in hinder segments, the sexual in intermediate segments, and nothing in the forward segments.

The size of the mature asexual coenobia is not shown by any of the material at hand. Referring to the largest pictured specimen (Plate 3, fig. 11) we find that this coenobium, having daughters of about 80 μ diameter, measures about 750 μ. In view of the fact that the daughters probably grow to more than 300 μ diameter before birth it is evident that robust asexual coenobia when mature reach a diameter of about 1,000 μ.

VOLVOX BARBERI sp. nov.

The specimen represented by Plate 4, figs. 13 and 14, has been selected for the type of this species. This specimen appears to have been fixed in a chrom-acetic solution, lightly stained with a reddish stain, and mounted with others from the same collection under a sealed cover in glycerine which had been concentrated from a 10 per cent solution by evaporation.

The upper and lower sides of the specimen require a difference in focus of about 370 μ. An estimate of the thickness

of the specimen compressed under the cover, based on an assumed optical density of the mounting medium of 1.4, is 518 μ. The short and long diameters of the specimen measured about 790 and 930 μ. The number of cells in the specimen was estimated to be 31,500 by assuming a mean diameter of 737 μ and counting 149 cells in an irregular space, taken near the equator, having an area of 8,100 sq. μ. The distribution of the somatic cells is not so regular as might be expected, many of the cells standing closer to one neighbor than to the others. The average distance between centers of somatic cells is about 8 μ in the equatorial region, about 14 μ around the anterior pole, and about 7 μ near the posterior pole.

The protoplasts vary from ovoid at the anterior pole to pear-shaped at the posterior pole. The surface view shows them roundish with one, two, or sometimes more angles, and about 3.5 μ in diameter. The hexagonal intercellular membranes can barely be made out. The one, two, or more angles of the protoplasts are the bases of more prominent filaments. Most of the intercellular filaments are hardly visible. Between any two neighboring protoplasts there is no indication of the occurrence of more than one filament. In the median optical section of the coenobium there is to be seen a clearly defined inner membrane about 22 μ within the outer membrane of the colony. The protoplasts occupy a portion of the outer third of the space between these two membranes.

The oospores in this specimen, numbering about 224, were, as nearly as practicable, all sketched with a camera lucida for counting. An obstacle that precludes absolute accuracy in this sketching is the overlapping of the oospores at the sides of the colony, which is greater than at the posterior pole. There are no oospores in the anterior quarter of the colony, and there is a scarcity of them about the posterior pole. They all lie near the periphery of the colony, within and close to the inner membrane which, as before stated, is about 22 μ below the outer membrane. The wall of the spore (see Plate 4, fig. 14) is developed into spines which are rather broadly conical in form. These spines do not stand so close together as those of the type specimen of *V. merrilli,* are not so long, do not have such attenuate form as in that specimen, and are more finely or sharply pointed. The spines appear to be hollow, thin-walled, and comparatively colorless, though the latter character may have resulted from action of the fixing agent. Their peripheral count is about fifteen. The diameter of the spore, including the

spines, is about 43 μ; excluding the spines, about 34 μ. The spines are about 3.5 to 5.5 μ high.

The oospheres vary, probably due to difference in degree of maturity, some nearly filling the spherical lumen of the spore wall, others being excentrically shrunken away from the wall, the latter being commoner in the posterior part of the colony. The protoplasm is coarsely granular in most of the oospores, and stained reddish, and the nucleus cannot be distinguished.

More or less directly over each oospore, seen in surface view of the colony, there is a vacancy in the layer of somatic cells. There are a few other vacancies, one on the upper and two on the lower side, in the layer of somatic cells, that are supposed to represent antheridial sites. Enlarged somatic cells are not noticeably present.

The specimen has a break running across the near side a little forward from the oosporic region, and a λ-shaped crease in the middle of the near side. Fungus hyphae on the left side of the anterior pole are a reminder of the futility of depending on exposure of glycerine to the atmosphere in shallow dishes for the purpose of evaporation. Some of these hyphae penetrate the colony. There are others on and in the lower side.

The material from which this specimen was taken was collected from a flood pool near the Pasig railway station, about 10 kilometers east of Manila, at some time between July 19 and August 31, 1914. The collection was designated by the Roman number V for the purpose of labeling slides prepared from the collection.

Scattered over the surface of the colony, embedded in the membranes, are numerous specimens of an endophytic alga that is considered to belong in the genus *Chlorosphaera* Klebs. A great variety of stages of the life history of this organism are present. The most conspicuous are the resting spores, of which a dozen are to be seen in Plate 1, fig. 1.

Six other equally mature female coenobia of about the same size and with about the same number of spores are present on the same slide with the type specimen. There are also two smaller ones with mature oospores, one about 545 by 708 μ with 73 oospores and the other about 430 by 516 μ with 65 oospores.

Immature female coenobia are also present. One measuring 580 by 600 μ has the oogonia about 20 μ wide, and another about 885 by 915 μ has oogonia about 25 μ wide. In the former the oogonia are only partly somewhat pear-shaped, in the latter

they are mostly so. In the former five or six partly developed antheridia are visible, and in the latter four can be seen, three of them sperm globoids and the other cup-shaped and probably immature. The preparation is not suitable for observing the details of the antheridia.

A nearly mature asexual coenobium with eight symmetrically arranged daughters is shown in Plate 5, fig. 15. This is on the same slide with the type specimen and therefore from the same collection. It is compressed under the cover to about 450 μ and measures about 950 μ in diameter. The number of cells in the mother was estimated variously at 30,000 and 38,000, and those in one of the daughters were estimated at about 26,000. This daughter is about 300 μ in diameter and has ciliated cells about 3.5 μ in diameter and closely crowded. It has also a few reproductive cells of about 10 μ. The layer of the somatic cells of the mother and their membranes is about 23 μ thick and the protoplasts are in the outer half of this thickness. The protoplasts in the front of the coenobium are larger, ovoid, and about 3.5 μ in diameter. Those at the back are smaller, pear-shaped, with the outer half about 1.2 and the inner half about 2.5 μ wide. In length they are as large as the forward somatic protoplasts. The protoplasts are spaced about 7 μ at the back and about 10.5 μ at the front. The connecting filaments are delicate.

On the same slide there are other mature asexual coenobia. One shows a rear view of a beautifully symmetrical group of eight daughters, two others show oblique views of the same number of daughters. Two others show seven large daughters each, but with a vacant space among the daughters. One mother with half-grown and one with one-fifth-grown daughters have also eight each. So eight seems to be the number of gonidia characteristic of this lot of material.

From a pond, C, in Pasay, several kilometers distant from the source of the type material, there was collected on September 20, 1914, and fixed on the next day, material of *Volvox barberi* that included asexual coenobia having the number of daughters variable.

One, shown in Plate 5, fig. 16, has only four daughters. They are distributed around the equator of the coenobium. The specimen presents nearly a side view and measures in the photograph 540 by 580 μ. The approximate correctness of the magnification of this figure is indicated by the scale reproduced below the figure. This scale is a reproduction of a stage mi-

crometer scale with smallest divisions 10 μ each, that was photographed on the same plate as the specimen, with the same adjustment of the apparatus. The daughters are about 125 μ in diameter and appear to be developing cilia on their cells. There are indications that three or four other reproductive bodies were present in the hinder half of the coenobium and distributed symmetrically. They were either abortive and degenerated, or they formed antheridia.

Another, shown in Plate 5, fig. 17, has six daughters that are shown in a posterior polar view. This is from another slide of the same collection. The somatic cells mostly appear too large because of being out of focus.

On the same slide with the coenobium having four daughters there are fourteen coenobia in about the same degree of maturity. They have—

3, 4, 5, and 6 daughters in
2, 5, 5, and 2 mother coenobia, respectively.

With the material just described there is a variety of stages of asexual *Volvox* coenobia ranging from young ones with gonidia of about 10 μ divided into two cells to older ones with the reproductive bodies many-celled. It is not evident at first sight that these are of the same species that is being described here, for the somatic cells of these young and intermediate coenobia are more robust than those of the type material of *Volvox barberi*, and they appear to be fewer in number. Still, I am inclined to believe that they are the same species. They show a tendency to have eight reproductive bodies, even when fewer are developing. In one such, for example, there are four embryo daughters of about 57 μ distributed equatorially and forming a symmetrical group, and halfway back to the hinder pole there is a group of four small reproductive bodies similarly arranged. One of these is simply a pair of twin stellate cells, each of not quite twice the diameter of the somatic cells. The three others are *Pandorina*-like bodies of about sixteen cells, measuring about 18 by 21 μ.

A small coenobium that appears to belong to *Volvox barberi* is shown in Plate 3, fig. 12. It measures about 210 by 250 μ and contains about 1,800 somatic cells. It is without reproductive bodies. It serves to illustrate how small and relatively few-celled some members of the large, many-celled species may be.

That coenobia of *Volvox barberi* sometimes occur with both asexual and sexual reproductive bodies is shown by a specimen

on the type slide. In this there are two bodies that appear to be diseased or parasitized daughters of about 73 and 88 μ diameter, in a coenobium of 680 by 760 μ. This coenobium has a large distinct vegetative forward area. The two daughters occupy positions corresponding to those of two adjoining members of a posterior quartet in a typical coenobium with eight daughters. The quarter sphere occupied by the two daughters is free from oospores. The latter are distributed, then, in the other posterior quarter sphere and around the equatorial margin of the forward half of the coenobium; that is, between the equator and the forward vegetative area. About one-third of the oogonia appear to have been unfertilized, for they are deficient in reserve material and have formed no spore walls. Those that have formed spore walls have developed them in considerable variety.

The variation in the spore walls of the aforementioned coenobium are noteworthy. A few are almost smooth; some are smooth with a few scattered rounded warts; a few are wavy to a very marked degree; and many have a smooth wall with numerous but not crowded conical warts or rounded warts. Some of these are of the form represented by Janet ('14, p. 7, fig. 1) for *Volvox globator*. They vary in size, but an average one measures about 42 μ over all and 34 μ without the warts, the latter being about 4 μ high or less. On some spores the warts are rounded and on others conical.

A COMPARISON OF THE SPECIES OF VOLVOX

Considering only the species here classified as *Volvox* there are five; *Volvox globator* of Europe, *V. perglobator* of North America, *V. rousseleti* of Africa, and *V. merrilli* and *V. barberi* of the Philippine Islands.

To facilitate a comparison of these species some of their characters have been set down in parallel columns in Table 1. The data here used are not all uniformly representative of the species to which they pertain, but it is thought that they will serve as a good first approximation.

The best means of distinguishing between the two Philippine species of *Volvox* is by the size and form of the somatic cells of the coenobia. Those of *V. merrilli* are relatively large, wider than high, and stellate, much like those shown in Meyer's drawings of those of *V. globator* reproduced herewith as text figs. 3 and 4. Those of *V. barberi* are smaller, higher than wide, and vary from more or less stellate in younger coenobia to ovoid about the forward pole and pyriform about the hinder

TABLE 1.—*Characters of the species of Volvox.*

Distribution and characters.	*V. globator.*	*V. perglobator.*	*V. rousseleti.*	*V. merrilli.*	*V. barberi.*
Geographical distribution	Europe	North America	Africa	Philippine Islands	Philippine Islands.
Coenobia, form	Subglobose	Asexual unknown; female oval.	Asexual subglobose; sexual ellipsoidal.	Asexual subglobose; sexual ellipsoidal.	Asexual subglobose; sexual ellipsoidal.
Coenobia, size	420 to 800 μ	1,000 to 1,600 μ	1,125 to 1,240 μ	Asexual about 1,000 μ; sexual 690 by 750 μ.	Asexual 950 μ; sexual 790 by 930 μ.
Cells	1,000 to 15,000	Excessively numerous	25,000 to 50,000	Asexual 17,800; sexual 12,100.	Asexual 31,500; sexual 30,000.
Protoplasts, form	Stellate in surface view	Stellate in surface view	Stellate, small, densely aggregated.	Stellate; wider than high	Stellate to ovoid and pyriform, very small; higher than wide.
Protoplasts, size	3 to 5 μ	3 to 5 μ (implied)	4 to 6.5 μ	4 to 8 μ	3.5 μ and less.
Protoplasmic connections	Thick and continuous with the processes of the protoplast.	Becoming long and slender.	Relatively broad	Coarse; becoming finer and longer.	Fine.
Gonidia	8, seldom more or less		8	8 or less	8 or less.
Oogonidia	12 to 40, average 30	More than 100; even 300 to 400.	120 to 150; average 128	129, more or less	224, more or less.
Oospore wall	Verrucose with conical warts about 7 to 8 μ high.	"Crenate"	Densely clothed with strong conical spines about 11 to 12 μ high.	Densely clothed with strong conical spines about 11 μ high.	Densely covered with conical spines about 3.5 to 5.5 μ high.
Spore, diameter	Exclusive of warts, 48 μ		Exclusive of spines, 44 μ	Exclusive of spines, 36 to 42 μ.	Exclusive of spines, about 34 μ.
Androgonidia	Usually 5, more or less	50 to 100 in each male coenobium.	Several hundreds in each male coenobium.	Few	Few.
Antheridia	Sperm platelets or globoids.	Flattened sperm globoids	Sperm platelets?	Sperm globoids	Sperm globoids.
Antheridia and oogonia	Usually in the same coenobia.	In different coenobia	In different coenobia	In the same coenobium	In the same coenobium.

pole in more mature coenobia. A sketch from living material of *V. barberi* was made on July 31, 1914, and is reproduced herewith as text fig. 5. This represents an optical section view of the coenobium wall of a nearly mature asexual specimen. The pear-shaped protoplasts are more especially characteristic of the hinder parts of the coenobia. In the forward parts the protoplasts are ovoid.

The following key to the species of *Volvox* is offered in the absence of data that would be necessary for the construction of a key based entirely on vegetative or asexual characters.

Key to the species of Volvox.

1. Oospore walls angularly wavy	V. globator.
1. Oospore walls crenate	V. perglobator.
1. Oospore walls spinose	2.
2. Sexual coenobia dioecious	V. rousseleti.
2. Sexual coenobia monoecious	3.
3. Somatic protoplasts large and broad	V. merrilli.
3. Somatic protoplasts small and narrow	V. barberi.

A form of *Volvox* described by Carter ('59) at Bombay, India, was identified by him with *Volvox stellatus* Ehrenberg, a species reduced by all European workers to *V. globator.* This form is most nearly like the two Philippine species. Though the descriptive data furnished by Carter are insufficient to enable one with certainty to assign the form to one or the other of the species, the evidence is rather in favor of considering it to be *V. barberi.*

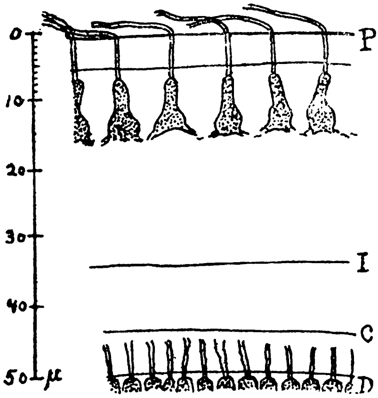

FIG. 5. *Volvox barberi* sp. nov. Coenobium wall of a nearly mature asexual coenobium, in optical section from a living specimen, showing protoplasts and the visible limits of the membranes.

SPECIES EXCLUDED FROM VOLVOX

Species that have been described under the name of *Volvox* and that are to be left out of this genus and assigned to other genera are: *Volvox carteri* Stein ('78), for which *V. weismannia* Powers ('08) is another name, *V. tertia* Meyer ('96), and *V. africana* West ('10), all of which are characterized by having rounded protoplasts without connecting filaments

and by having large gonidia that are differentiated early; and *V. spermatosphaera* Powers ('07 and '08) in which the differentiation of the gonidia is not so early. Another, described as a "second form of *Volvox*" by Powers ('07), has received the generic name *Besseyosphaera* (Shaw, '16).

A satisfactory treatment of the two Philippine species of *Volvox*, based on a more extended study of both living and preserved material from various localities, has been most greatly interfered with by the presence in the same habitat of a number of other species of large Volvocaceae presenting novel features that insistently claimed attention.

LITERATURE CITED

CARTER, H. J. ('59). On fecundation in the two Volvoces, and their specific differences. Ann. & Mag. Nat. Hist. III **3** (1859) 1–20, pl. 1.

COHN, F. ('75). Die Entwickelungsgeschichte der Gattung Volvox. Festschr. z. Göpperts 50 jährig. Doktorjubiläum. Breslau (1875) 34 pp., 1 col. pl.

EHRENBERG, C. G. ('38). Die Infusionsthiere als vollkommene Organismen. Berlin and Leipzig (1838). (Not seen.)

HARPER, R. A. ('18). Binary fission and surface tension in the development of the colony in Volvox. Brooklyn Bot. Gar. Mem. **1** (1918) 154–166. Pl. 2 and figs. 1–4.

JANET, C. ('12). Le Volvox. Limoges (1912) 151 pp.

JANET, C. ('14). Note préliminaire sur l'oeuf du Volvox globator. Limoges (1914) 12 pp.

KLEIN, L. ('89A). Morphologische und biologische Studien über die Gattung Volvox. Jahrb. f. wiss. Bot. **20** (1889) 133–211, pls. 10–12.

KLEIN, L. ('89B). Neue Beiträge zur Kenntniss der Gattung Volvox. Ber. d. deutschen bot. Ges. **7** (1889) 42–53, pl. 3.

KLEIN, L. ('90). Vergl. Untersuchungen über Morphologie und Biologie der Fortpflanzung bei der Gattung Volvox. Ber. d. naturf. Ges. Freiburg i. B. **5** (1890) 92 pp., pls. 2–6.

MEYER, A. ('95). Ueber den Bau von Volvox aureus Ehrenb. und Volvox globator Ehrenb. Bot. Centralbl. **63** (1895).

MEYER, A. ('96). Die Plasmaverbindung und die Membranen von Volvox, mit Rücksicht auf die thierischen Zellen. Bot. Zeit. **54**[1] (1896) 187–217, pl. 8.

OLTMANNS, F. ('04). Morphologie und Biologie der Algen. Jena (1904 and 1905).

OVERTON, E. ('89). Beitrag zur Kenntniss der Gattung Volvox. Bot. Centralbl. **39** (1889) 39 pp., 4 pls.

POWERS, J. H. ('07). New forms of Volvox. Trans. Am. Microscop. Soc. **27** (1907) 123–149, pls. 11–14.

POWERS, J. H. ('08). Further studies in Volvox, with descriptions of three new species. Trans. Am. Microscop Soc. **28** (1908) 141–175, pls. 23–26.

SHAW, W. R. ('16). Besseyosphaera, a new genus of the Volvocaceae. Bot. Gaz. **61** (1916) 253 and 254.

SHAW, W. R. ('18). Some microtechnical methods and devices. Philip. Journ. Sci. Bot. **13** (1918) 241–261.

SHAW, W. R. ('19). Campbellosphaera, a new genus of the Volvocaceae. Philip. Journ. Sci. **15** (1919) 493–520, 2 pls.

WEST, G. S. ('10). Some new African species of Volvox. Journ. Quekett Mic. Club II **11** (1910) 99–104, pl. 3.

WEST, G. S. ('18). A further contribution to our knowledge of the two African species of Volvox. Journ. Quekett Mic. Club II **13** (1918) 425–428, pls. 29 and 30.

ZIMMERMANN, W. ('21). Zur Entwickelungsgeschichte und Zytologie von Volvox. Jahrb. f. wiss. Bot. **60** (1921) 256–294. 1 pl. and 2 figs.

ILLUSTRATIONS

[Photomicrographs of *Volvox* species, from specimens mounted in glycerine, taken by W. R. Shaw and E. Cortes at the Bureau of Science, Manila.]

PLATE 1. VOLVOX MERRILLI SP. NOV.

FIG. 1. The type specimen, a sexual coenobium with ninety-two nearly ripe oospores. × 100.

2. A portion of the surface of the same coenobium showing the somatic cells. × 400.

3. Oospores below the surface of the same part of the coenobium that is shown in the preceding figure. × 400.

PLATE 2. VOLVOX MERRILLI SP. NOV.

FIG. 4. Another view of the same oospores with the shadows of the overlying somatic cells not so dark and the spines shown with less depth of focus. × 400.

5. Oospores in another coenobium of the same species. One is smaller than the typical spores, and resembles those of the other species. ×400.

PLATE 3. FIGS. 6 TO 11, VOLVOX MERRILLI SP. NOV.; FIG. 12, VOLVOX BARBERI SP. NOV.

FIG. 6. A young sexual coenobium showing three or four antheridia in different stages of formation. × 100.

7. A small asexual coenobium with only two embryo daughters. × 100.

8. A small coenobium with eight reproductive bodies, probably gonidia. × 100.

9. A sexual coenobium a little older than that of fig. 6, showing three or four antheridia in different stages of development, and numerous oogonidia that are a little larger than the somatic cells. × 100.

10. A very small coenobium with three reproductive bodies that are gonidia and have each divided into eight cells. × 100.

11. A half-grown asexual coenobium containing seven embryo daughters. × 100.

12. A very small coenobium without reproductive bodies. × 100.

PLATE 4. VOLVOX BARBERI SP. NOV.

FIG. 13. The type specimen; a sexual coenobium with two hundred twenty-four nearly ripe oospores. ×100.

14. A portion of the same coenobium showing in the middle the nearly ripe oospores, and in other parts somatic cells that are in focus because of the bent state of the coenobium wall. × 400.

PLATE 5. VOLVOX BARBERI SP. NOV.

FIG. 15. A nearly mature asexual coenobium with eight daughters that have developed cilia. × 100.

16. An asexual coenobium with four daughters that are beginning to develop cilia. ×100.

17. An asexual coenobium with six daughters that have begun to develop cilia. × 100.

TEXT FIGURES

FIG. 1. *Janetosphaera aurea* (*Volvox aureus*). Diagram of cells and membranes as seen in surface view. After Meyer.

2. *Janetosphaera aurea* (*Volvox aureus*). Diagram of cells and membranes as seen in cross section of coenobium. After Meyer.

3. *Volvox globator.* Diagram of cell membranes as seen in a cross-section view of a portion of the coenobium wall. After Meyer.

4. *Volvox globator.* Diagram of cell membranes as seen in surface view and tangential sections of the coenobium wall. After Meyer.

5. *Volovox barberi* sp. nov. Coenobium wall of a nearly mature asexual coenobium, in optical section from a living specimen, showing protoplasts and the visible limits of the membranes.

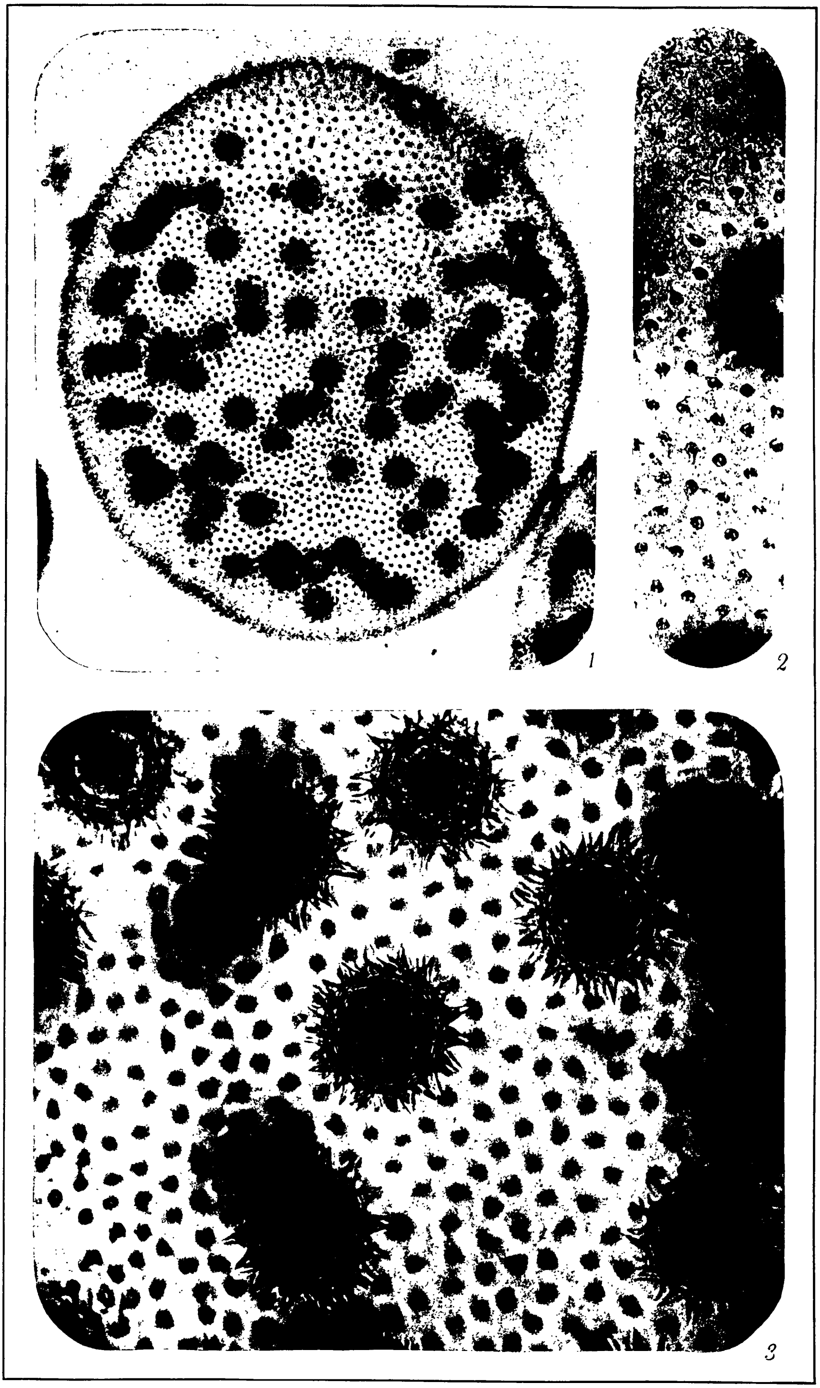

PLATE 1. VOLVOX MERRILLI SP. NOV.

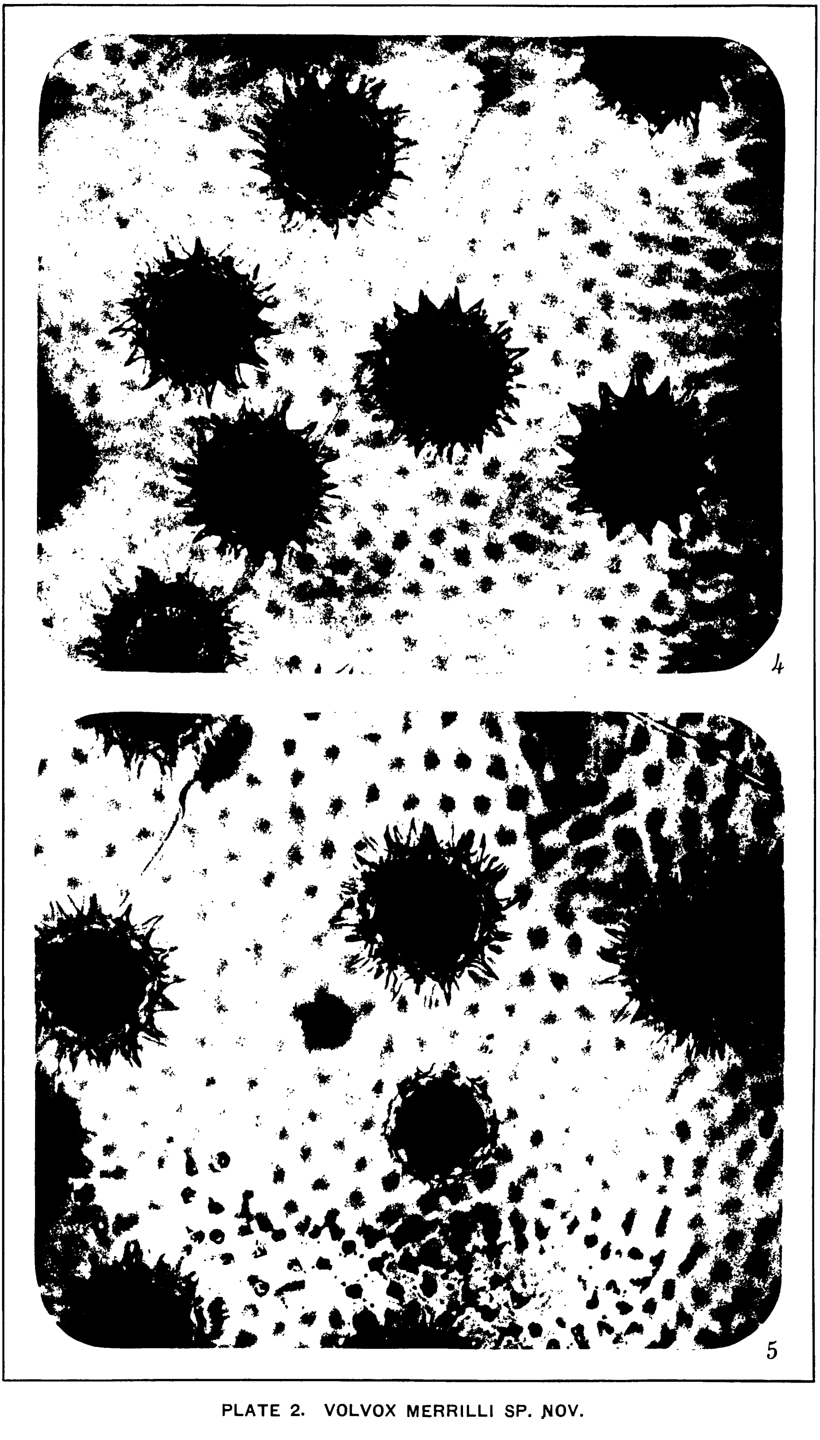

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PLATE 2. VOLVOX MERRILLI SP. NOV.

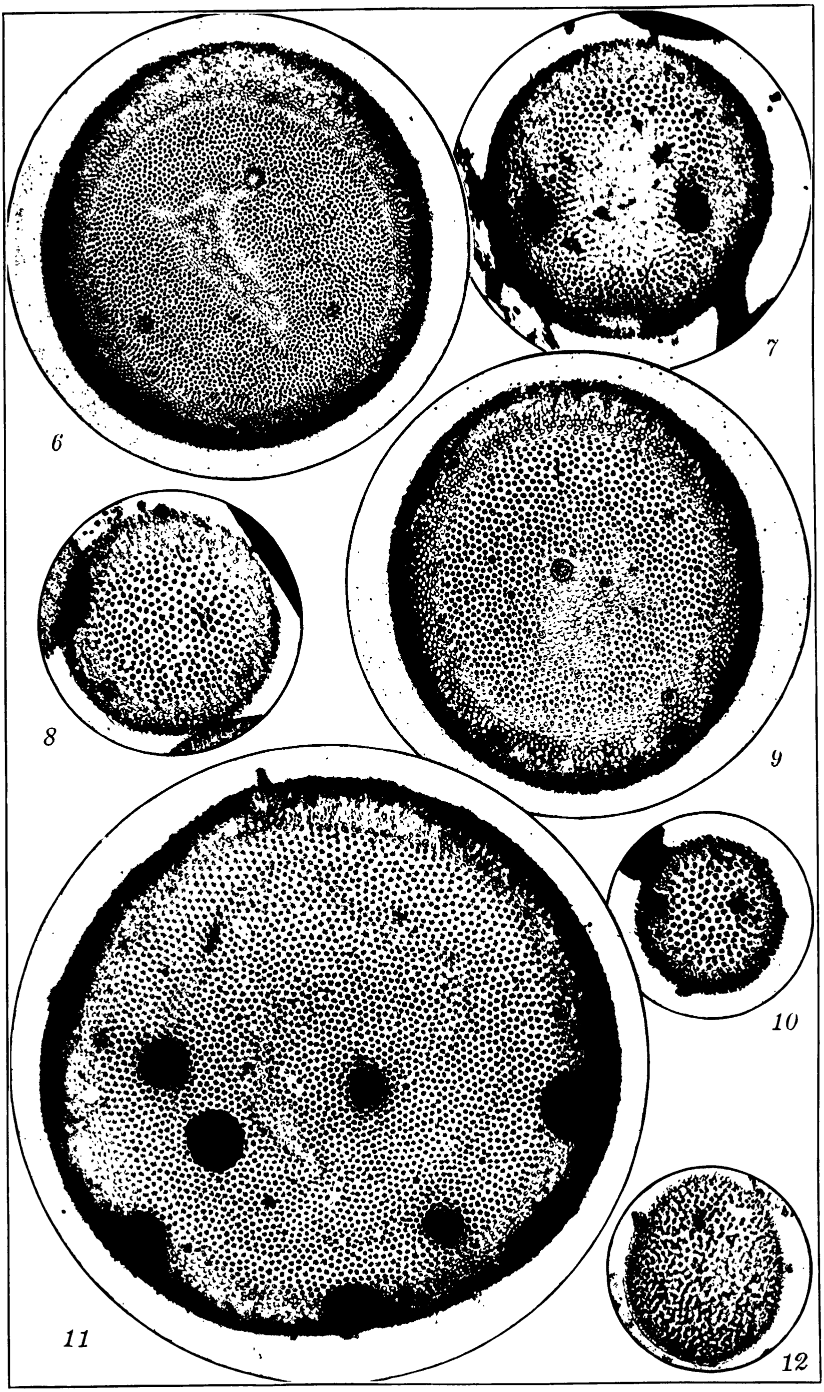
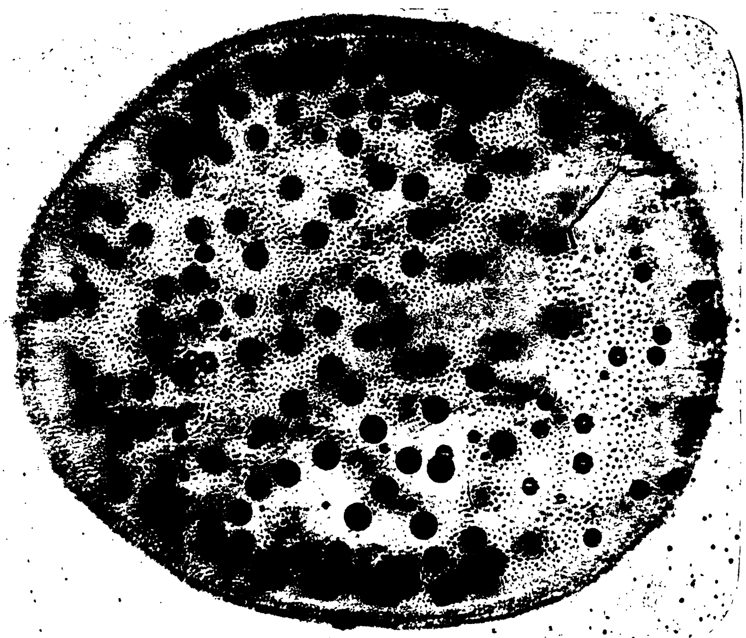
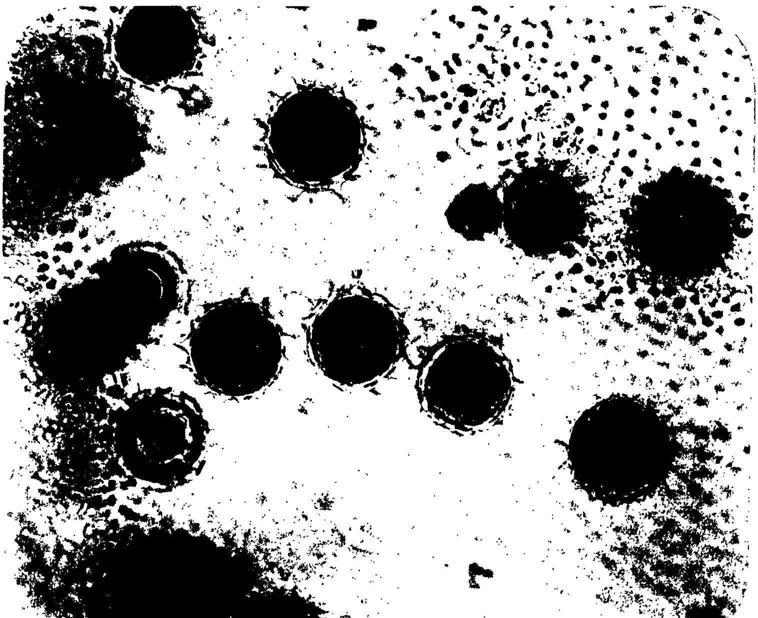


PLATE 3. VOLVOX MERRILLI AND V. BARBERI SPP. NOV.



13



14

PLATE 4. VOLVOX BARBERI SP. NOV.

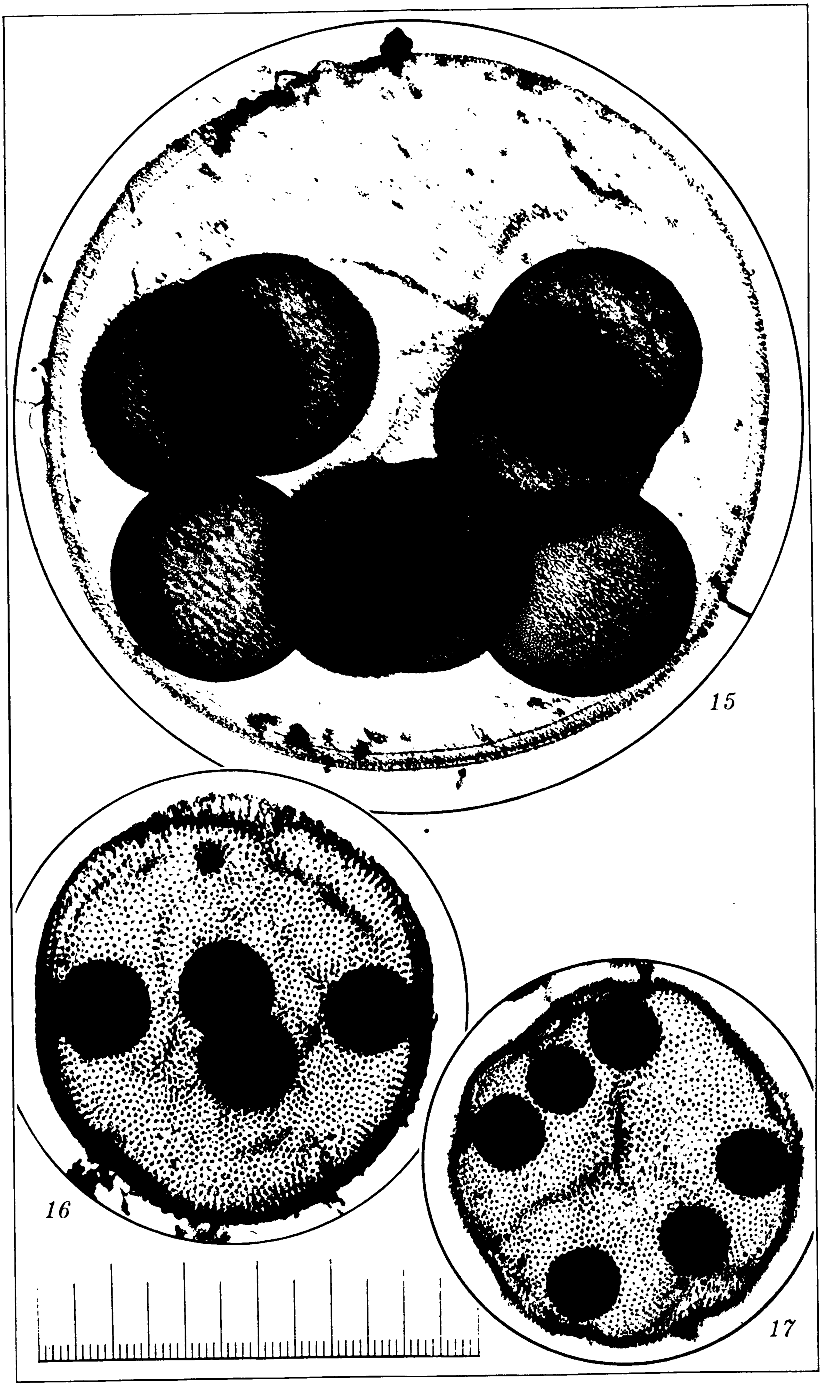


PLATE 5. VOLVOX BARBERI SP. NOV.

EXTRACTION OF COPRA CAKE WITH SOLVENTS

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and

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INTRODUCTION

In recent years the demand and prices for animal fats, such as lard and butter, have been steadily increasing. The animal industries of the world, while capable of more extensive development, seem hardly able to provide the abundant supplies of butter and lard which will be desired in the future and it appears that there will probably be a permanent shortage of animal fats. This has led to a greatly increased use of vegetable fats by European and American makers of artificial butter, resulting in an unusual demand for these vegetable products. The hydrogenation process, by which vegetable oils are converted to hard solid fats which can be substituted for animal fats, has also given an impetus to the development of the vegetable-oil industries. Since coconut oil is one of the most popular ingredients of artificial butters and edible fats these trade conditions in vegetable fats have naturally affected the Philippines, which is one of the largest coconut-producing countries in the world.

Formerly, a large proportion of Philippine coconuts was converted into copra, which was shipped to the United States and to European countries where the oil was expressed. When copra is allowed to stand for a considerable length of time before shipment it tends to deteriorate, causing a loss in the quality and quantity of the oil. Obviously, in so far as this deterioration is concerned, it is more economical to produce oil in the countries where the coconuts are grown. This would logically reduce the bulk of the shipments and avoid possible losses due to spoiling. The shortage of shipping space during the world war naturally made it even more advisable to express the oil

near the source of coconut production. The result of these various conditions has been the establishment of a considerable number of oil mills in the Philippines. The increase in the coconut-oil business in the Philippines is shown very clearly in Table 1, which gives the exports of copra and coconut oil from 1913 to 1920.

TABLE 1.—*Amount and value of copra and coconut oil exported from the Philippines from 1913 to 1920* [a]

Year.	Copra.		Coconut oil.	
	Amount.	Value.	Amount.	Value.
	Kilograms.	*Pesos.*	*Kilograms.*	*Pesos.*
1913	82,219,363	19,091,448	5,010,429	2,292,678
1914	87,344,695	15,960,540	11,943,329	5,238,366
1915	139,092,902	22,223,109	13,464,169	5,641,003
1916	72,277,164	14,231,941	16,091,169	7,851,469
1917	92,180,326	16,654,301	45,198,415	22,818,294
1918	55,061,736	10,377,029	115,280,847	63,328,317
1919	25,094,027	8,839,376	139,942,612	73,719,504
1920	25,803,044	7,433,741	77,571,405	46,537,773

[a] Annual Report, Insular Collector of Customs, Manila (1920).

The two commercial methods employed to obtain coconut oil from copra, which is the dried meat of the coconut, are the pressure (expeller and hydraulic) and the extraction processes. In the pressure process, the copra is ground, heated, and subjected to pressure. The expeller oil cake which remains after the first expression still contains a considerable quantity of oil (about 10 to 15 per cent) and is subjected to a second expression by means of hydraulic presses after which the hydraulic cake contains only a small percentage of oil (about 4 to 7 per cent). The coconut oil thus obtained is filtered and stored in large tanks, ready for domestic use or export. The oil cake (copra cake) which remains after the oil has been expressed is used as cattle food or, sometimes, as fertilizer or fuel. In the extraction process the dried copra is ground sufficiently fine to break the oil cells as much as possible. The material is then treated with some volatile solvent such as benzene or carbon tetrachloride. The solvent containing the dissolved oil is drawn off from the extracted residue (pomace) and filtered. The oil is then separated from the solvent by distillation, after which the solvent is returned to storage and used for subsequent extractions. Solvent-extraction plants have been operating in Germany and England for some years, and several plants are now

in operation in the United States where they are extracting various oil seeds and oil cakes, such as coconut, cottonseed, corn, castor beans, palm kernels, etc. Of the solvents which have been tried Shrader[1] states that benzene and trichlor ethylene appear to give the best results. In the Philippines all companies, with one exception, use the pressure process. Recently an extraction plant was built, but we have been unable to obtain any data concerning its products.

One of the principal duties of the oil chemist in a coconut-oil mill is to determine the amount of oil remaining in the copra cake, and usually many analyses are made during the day. The standard method employed for this purpose is to extract the copra cake with ether, using the well-known Soxhlet apparatus. Since ether is a very volatile and inflammable liquid and somewhat troublesome to handle in an oil-mill laboratory in a warm tropical country, it was thought that possibly some other, more suitable solvent might be used in place of ether.

The object of the present investigation is to determine the comparative results obtained by extracting copra cake with various solvents.

SAMPLE

The samples of copra cake used in this investigation were obtained from one of the largest coconut-oil mills in Manila. We used average samples of both expeller and hydraulic cakes. The cakes were broken up into rather fine pieces and quartered twice after which they were powdered in mortars and sieved until sufficiently fine for the entire sample to pass a 50-mesh screen. The powdered sample was then heated in an air bath about ten minutes at 80°. Analysis of these cakes gave the results recorded in Table 2.

TABLE 2.—*Analyses of copra cake.*[a]

Constants.	Expeller cake.	Hydraulic cake.
	Per cent.	*Per cent.*
Ash	4.76	7.51
Crude fiber	6.84	7.47
Protein (N × 6.25)	20.94	20.71
Moisture	3.40	7.29
Free fatty acids (as oleic)	5.05	5.28

[a] Analyses made by F. Agcaoili and W. Salvador, Bureau of Science.

[1] Shrader, J. H., Chem. Met. Eng. 25 (1921) 94.

PROCEDURE

The solvents used in this investigation to extract coconut oil from copra cake were ether, carbon tetrachloride, benzene, petroleum ether, chloroform, acetone, absolute alcohol, alcohol (95 per cent), and methyl alcohol. Preliminary experiments showed that coconut oil dissolves readily in these various substances. The solvents were purified by special means when necessary and distilled several times until they showed a constant boiling point. In working with these solvents we employed the usual Soxhlet extractors. Two electric heaters containing six extractors each were used. Since the boiling point of the solvents varied from 34° to 80° the electric heater employed for the higher-boiling solvents was arranged to give a somewhat higher temperature than the other heater used for the lower-boiling solvents. The extraction temperature was regulated so that the rate of extraction was approximately the same for each solvent and for each interval of time. Although the various solvents boil at different temperatures, by placing pieces of asbestos under the extraction flasks the heat can be regulated so that each solvent will require approximately the same length of time (about twenty-four minutes) to syphon. When the extraction was completed for a definite interval of time the heating was continued until most of the solvent had distilled into the upper part of the apparatus and was just about ready to syphon. The heating was then discontinued. The extraction flask which still contained a small amount of solvent was disconnected and placed in an electric oven heated to a temperature of about 75°. The flask containing the extracted residue was allowed to remain in the oven until all the solvent had apparently evaporated, after which it was weighed. The flask was again heated and weighed several times until a constant weight was obtained. Since ether is the solvent that is commonly employed to extract oil from copra cake, we used the results obtained with ether as a standard for comparison.

In all our extraction experiments we used a 2-gram sample of material, and the experiments were always performed in duplicate. The duplicate extractions for each interval were naturally carried out with fresh samples of copra cake. In some cases, when the results of our duplicates did not agree very closely, we performed several series of duplicate experiments until we obtained fairly constant results.

In many series of experiments we varied the intervals of time for a particular solvent from three to thirty-six hours.

In these experiments the material was exposed to the solvent for a longer period of time than is customary in technical analysis, which requires usually only twelve hours.

RESULTS

The average results obtained by extracting expeller copra cake with different solvents are recorded in Table 3. These figures give a fairly accurate idea as to the relative extractive power of the solvents with copra cake.

TABLE 3.—*Extraction of expeller copra cake with solvents.*

Solvent.	Extraction.					
	3 hours.	6 hours.	8 hours.	10 hours.	24 hours.	36 hours.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Ether	13.38	13.49	13.58	13.69	13.80	13.90
Carbon tetrachloride	13.28	13.55	13.56	13.32	13.45	13.58
Benzene	13.29	13.50	13.67	13.85	13.93	14.42
Petroleum ether (40° to 55°)	13.36	14.34			15.10	
Chloroform	14.22	15.04	15.28	15.32	15.40	15.46
Acetone	15.43	15.80	16.13	16.39	17.04	18.19
Ethyl alcohol (absolute)	24.74	26.55	28.12	29.05	31.51	33.90
Ethyl alcohol (95 per cent)	27.27	29.18	30.52	31.85	32.87	34.05
Methyl alcohol	30.36	32.66	33.35	33.80	34.40	35.47

Copra cake contains not only coconut oil but also other substances, such as crude fiber, protein, and small amounts of nonfatty substances. In extracting copra cake with different solvents we would naturally expect some of the solvents to give a greater percentage of extraction than others, because the nonoleaginous material in the copra cake is likely to be more soluble in some solvents than in others.

The figures given in Table 3 show that the percentage of extraction is approximately the same for ether, carbon tetrachloride, and benzene. Chloroform and acetone give a somewhat higher percentage while the alcohols give a very high percentage, especially methyl alcohol, which gives over 30 per cent for a three-hour period. Petroleum ether gives about the same result as ether for a three-hour period, but for longer periods the extraction is somewhat greater.

These results would seem to indicate that ether, carbon tetrachloride, and benzene dissolve less of the nonfatty substances than do the other solvents and should give more accurate results than chloroform, acetone, and petroleum ether which

probably dissolve a small quantity of those substances, and the alcohols which no doubt dissolve a considerable quantity.

With the exception of carbon tetrachloride, the figures showing the percentage extraction with the various solvents increase gradually with the time interval. With ether the increase is very gradual. Benzene, petroleum ether, and chloroform show a slightly greater increase, while acetone and the alcohols show a rather large increase. Absolute alcohol shows the greatest increase. Methyl alcohol gives a greater percentage extraction than any of the other solvents.

As carbon tetrachloride and benzene give about the same results as ether, our experiments would seem to indicate that either of these solvents could ordinarily be used in place of ether; and, if desired, the results could be calculated to the ether standard. These solvents are more easily handled in a tropical climate than ether, since they boil at a much higher temperature, and carbon tetrachloride also has the advantage that it is not inflammable.

Shrader [2] gives figures showing the speed of evaporation of various solvents. The data were obtained by allowing 5 cubic centimeters of various solvents to evaporate from an alberene dish under similar conditions. The results showed that ether evaporates in 2 minutes, carbon tetrachloride in 11.5 minutes, and benzene in 12.5 minutes. In so far as evaporation is concerned, carbon tetrachloride and benzene would evidently be very desirable solvents for routine work in the Tropics.

The figures (Table 3) showing the percentage extraction with carbon tetrachloride increase up to a period of six hours, after which there appears to be no further extraction. These results indicate that carbon tetrachloride probably dissolves less of the nonfatty substances in the copra cake than any of the other solvents and since carbon tetrachloride requires less time for extraction it would appear to be a very suitable solvent.

HYDRAULIC CAKE

In addition to our work on expeller cake we also carried out a few experiments on the extraction of hydraulic cake (Soxhlet method) with different solvents for a six-hour period only. The results are recorded in Table 4, which gives also, for purposes of comparison, the figures previously given in Table 3, showing the extraction of expeller cake for a six-hour period.

[2] Shrader, J. H., Chem. Met. Eng. **25** (1921) 99.

TABLE 4.—*Extraction of expeller and hydraulic copra cakes with solvents.*

[Six-hour period; Soxhlet method.]

Solvents.	Expeller cake.	Hydraulic cake.
	Per cent.	*Per cent.*
Ether	13.50	7.00
Carbon tetrachloride	13.56	7.27
Benzene	13.50	7.19
Chloroform	15.04	9.04
Acetone	15.80	10.17
Ethyl alcohol (absolute)	26.55	22.25
Ethyl alcohol (95 per cent)	29.18	25.36
Methyl alcohol	32.66	27.91

As shown by the figures in Table 4, ether, carbon tetrachloride, and benzene give about 7 per cent extraction with hydraulic cake and about 13.5 per cent with expeller cake. For both the expeller and the hydraulic cakes the percentage extraction with acetone is slightly higher than with chloroform, while with the alcohols there is a considerable increase. The figures given in Table 4 indicate that the extraction of expeller and hydraulic cakes with the same solvents give similar results.

NONFATTY MATERIAL IN COPRA CAKE

As previously stated copra cake contains not only coconut oil but also other substances, such as crude fiber, protein, and nonfatty material. The figures given in Tables 3 and 4 show that the percentage extraction with methyl alcohol is considerably greater than with carbon tetrachloride, which indicates that methyl alcohol dissolves not only the oil from copra cake but also a considerable quantity of nonfatty material. The nonfatty material may, therefore, be obtained by first treating the copra cake with carbon tetrachloride which dissolves out the oil and then extracting the oil-free cake with methyl alcohol.

As we thought that data on the nonfatty material might, perhaps, be of some interest we carried out these experiments. The extraction with carbon tetrachloride was made with the Soxhlet apparatus, using 10-gram samples and extracting about eight hours. Each sample was then filtered and dried, after which it was extracted with methyl alcohol. The extractions with methyl alcohol were combined, filtered, and most of the alcohol eliminated by distillation. The small quantity of alcohol remaining in the residue was then distilled out with partial vacuum. The nonfatty material was very thick and sticky and

had a dark color like molasses. It also had a somewhat sweet, acid odor. Analysis gave the results recorded in Table 5.

TABLE 5.—*Analysis of nonfatty material in expeller copra cake.*[a]

Acid value	49
Saponification value	145
Iodine value	6.61
Nitrogen (per cent)	1.26
Reducing sugars (per cent)	13.16

[a] Analysis made by B. Nelson, Bureau of Science.

The results given in Table 5 show that the nonfatty material contains 1.26 per cent nitrogen, which calculated as protein ($N \times 6.25$) would give 7.87 per cent.

Referring to alcohol-soluble proteins Osbourne [3] says that these alcoholic solutions can be concentrated to thick sirups from which the proteins may be obtained and that some proteins, zein and gliadin for instance, not only dissolve in ethyl alcohol but in other alcohols like methyl and propyl.

If the nitrogen in the nonfatty material is present as protein this is rather remarkable, since Osbourne states that proteins soluble in alcohol have been found only in the seeds of cereals and not in any other seed and in this respect these proteins show a marked contrast in their solubility to all other proteins of animal or vegetable origin.

Santos [4] carried out experiments on copra cake to determine the amount of proteins soluble in different solvents, and his results showed that with ethyl alcohol there is practically no alcohol-soluble protein. Since the extraction of copra cake with methyl alcohol gives a result which is only slightly higher than with ethyl alcohol (Tables 3 and 4), it would seem that copra cake probably contains no proteins which are soluble in either ethyl or methyl alcohol. Since the nonfatty material showed a high acid content (Table 5), possibly the nitrogen is in the form of amino acids or perhaps a slight proportion is present as protein (prolamins) and the remainder as amino acids.

As practically our entire sample was required for analysis, we were unable to continue further our investigation on the nonfatty material in copra cake. It might be interesting to isolate the acids from the nonfatty material and endeavor to identify them and ascertain what proportion, if any, are amino acids. A more thorough investigation of this material may,

[3] Osbourne, T. B., Vegetable Proteins (1919) 20, 32, and 34.
[4] Santos y Alvarez, F. O., Philip. Journ. Sci. 16 (1920) 186.

perhaps, give some very interesting results, and we expect to continue this work when time permits.

SUMMARY

The extraction of expeller copra cake with different solvents has been studied for various intervals of time. The results show that ether, carbon tetrachloride, and benzene give approximately the same percentage extraction. It appears, therefore, that either carbon tetrachloride or benzene could be used for the routine estimation of the oil remaining in copra cake.

Chloroform, acetone, and petroleum ether appear to dissolve not only oil but also small quantities of nonfatty substances from expeller copra cake while ethyl and methyl alcohols dissolve a considerable quantity. These solvents would, therefore, be undesirable for routine analysis showing the percentage of oil extracted from copra cake.

The extraction of hydraulic cake with different solvents gave results similar to those obtained with expeller cake.

By extracting expeller copra cake with carbon tetrachloride and afterwards extracting the oil-free cake with methyl alcohol the nonfatty material was obtained. Analysis of the nonfatty material showed that it had a high acid and saponification value and also contained a small percentage of nitrogen. The nitrogen may, perhaps, be present as amino acids or possibly a small portion of it as protein.

ALCYONARIEN VON DEN PHILIPPINEN

I. DIE GATTUNG ALCYONIUM LINNÆUS [1]

Von H. Lüttschwager

EINE TAFEL UND FÜNF TEXTFIGUREN

Das mir von Herrn Professor Kükenthal zur Bearbeitung anvertraute Material von den Philippinen enthält von der Gattung *Alcyonium* nur Vertreter der Untergattung *Eualcyonium* Broch, während von den beiden andern Untergattungen *Metalcyonium* und *Erythropodium* keine Exemplare vorliegen.

Nachdem ich bereits früher in meinen Beiträgen [2] die älteren Arten der Gattung kritisch untersucht habe, konnte ich an der Hand eines reichen mir vorliegenden Materials in eine umfassendere Prüfung der einzelnen Arten eintreten, und erkenne nunmehr 19 sichere Arten als zu *Eualcyonium* gehörig an, zu denen noch 5 unsichere Arten treten.

[1] This is the first of a series of four papers on Philippine Alcyonaria of the family Alcyoniidæ. These papers were prepared under the supervision of Dr. Willy Kükenthal, director of the Zoölogical Museum, Berlin, and the world's greatest authority on the classification of the Alcyonaria. They are particularly important in that they deal with forms found everywhere in the Islands on shallow reefs and banks. With the Notes on Philippine Alcyonaria, by Prof. S. F. Light, of the University of the Philippines, they give us an excellent start toward a knowledge of our rich littoral alcyonarian fauna. The keys to species, which make these papers particularly useful, are given in English as well as in German for the convenience of those not familiar with the latter language. As time permits, it is planned to treat other genera in a somewhat similar manner.

The Philippine material treated in these papers is from the zoölogical collection of the department of zoölogy, College of Liberal Arts, University of the Philippines. It was collected for the most part by S. F. Light on the joint expeditions of the University of the Philippines and the Bureau of Science to Port Galera, on the northeast coast of Mindoro, in 1912, and to Taytay, on the east coast of Palawan, in 1913. A few of the specimens were collected by Dr. L. E. Griffin and Prof. L. D. Wharton in the Bantayan Islands, near Cebu Island.—THE EDITORS.

[2] Beiträge zu einer Revision der Familie Alcyoniidae, Arch. f. Naturgeschichte Abt. A, Heft 10 (1914).

Zu *Eualcyonium* gehören folgende Arten:

Alcyonium digitatum Linn.
Alcyonium compressum Th. Stud.
Alcyonium glomeratum Hassal.
Alcyonium palmatum Pallas.
Alcyonium brioniense Kükth.
Alcyonium adriaticum Kükth.
Alcyonium pachyclados Klzgr.
Alcyonium brachyclados (Ehrbg.)
Alcyonium sphaerophorum (Ehrbg.)
Alcyonium sphaerophorum var. *sansibaricum* Cohn.
Alcyonium globuliferum Klzgr.
Alcyonium digitulatum Klzgr.
Alcyonium ceylonense May.
Alcyonium etheridgei Thoms. u. Mack.
Alcyonium paessleri May.
Alcyonium equisetiforme n. n. = *paessleri* Hickson.
Alcyonium fallax n. n. = *purpureum* Hickson.
Alcyonium valdiviae Kükth.
Alcyonium fauri Thoms.
Alcyonium gracillimum Kükth.

SPECIES DUBIAE

Alcyonium rotiferum Thoms.
Alcyonium bradleyi Verrill.
Alcyonium stellatum M. Edw.
Alcyonium laciniosum Esp.
Alcyonium molle (*stellatum*) Esp.

Zunächst will ich eine Bestimmungstabelle aller sicheren Arten geben.

Bestimmungstabelle. Untergattung Eualcyonium.

Mit wenig gelappten oder plump verästelten Stöcken.

1. Die Coenenchymspicula sind dünne Spindeln und Stäbe oder besitzen unregelmässige Gestalt und bilden Vierer und Achter........ 2.
   Die Coenenchymspicula sind Hanteln oder mit einer Einschnürung versehene hantelähnliche Gebilde........ 6.
   Die Coenenchymspicula sind dicke, stark bewarzte Spindeln. **A. gracillimum** Kükth.
2. Die Kolonie besteht aus einem schlanken sterilen Stiel und einer Anzahl dünner Aeste........ 3.
   Die Kolonie besteht aus kurzen, dicken, fleischigen Aesten........ 4.
3. Die Kolonie ist durchscheinend, die Polypen sind gross, hyalin. **A. palmatum** Pallas.
   Die Kolonie ist wenig durchsichtig, die Polypen sind gross. **A. adriaticum** Kükth.
   Die Kolonie ist undurchsichtig, die Polypen sind klein, gelb. **A. brioniense** Kükth.
4. Die Aeste sind nach oben zugespitzt und schlank.. **A. glomeratum** Hassal.
   Die Aeste sind oben nur abgerundet, bleiben aber plump und dick...... 5.
5. Die Polypen sind intensiv rot........ **A. compressum** Stud.
   Die Polypen sind heller, ganz hyalin........ **A. digitatum** Linn.
6. Die Coenenchymspicula sind typische Hanteln. Die Rindenspicula sind stets anders geformt als die Coenenchymspicula and sind keine Keulen........ 7.
   Die Coenenchymspicula sind keine typischen Hanteln, sondern Doppel-Walzen, -kugeln, auch scheibenförmig. Die Rindenspicula sind, wenn vorhanden, auch Keulen........ 11.

7. Die Rindenspicula sind biskuitartige Gebilde .... 8.
   Die Rindenspicula sind durch kurzen Hals verbundene Doppelkugeln. **A. globuliferum** Klzgr.
8. Die Zweige der Kolonie sind klein und rund .... 9.
   Die Zweige der Kolonie sind gross, fingerförmig .... 10.
9. Die Zweige stehen sehr dicht, platten sich gegenseitig ab, und die Kolonie erscheint gehirnartig .... **A. sphaerophorum** (Ehrbg.).
   Die Zweige sind etwas höher und stehen lockerer.. **A. digitulatum** Klzgr.
10. Die Coenenchymspicula haben einen kurzen dicken Hals. **A. pachyclados** Klzgr.
    Die Coenenchymspicula haben einen langen Hals mit wenigen Dornen an jedem Ende .... **A. brachyclados** (Ehrbg.).
11. Im Coenenchym liegen neben anderen Spicula auch einfache Keulen.. 12.
    Im Coenenchym liegen keine Keulen .... 15.
12. Die Kolonie besitzt einen deutlichen Stiel. **A. etheridgei** Thoms. und Mack.
    Die Kolonie besitzt keinen deutlichen Stiel .... 13.
13. Die Coenenchymspicula sind neben Keulen auch Doppelkugeln mit schwacher Einschnürung .... 14.
    Die Coenenchymspicula sind nur Doppelkeulen oder Hanteln mit starker Einschnürung, die Rindenspicula sind keulenförmig. **A. ceylonense** May.
14. Im Coenenchym liegen auch bedornte Spindeln .... **A. paessleri** May.
    Im Coenenchym liegen keine Spindeln .... **A. fallax** n. n.
15. Die Spicula sind walzenförmig mit schwacher Einschnürung und schwacher Bedornung .... **A. equisetiforme** n. n.
    Die Spicula sind scheibenähnlich oder bewarzte Ovale .... 16.
16. Die scheibenähnlichen Spicula sind mit schwachen Warzen besetzt. **A. fauri** Thoms.
    Die scheibenähnlichen Spicula sind stark bewarzt.... **A. valdiviae** Kükth.

Key to species of the subgenus Eualcyonium.

With sparsely lobed or bluntly branched stalks.

1. The coenenchyma spicules are slender spindles and rods or have an irregular shape, four- or eight-parted .... 2.
   The coenenchyma spicules are dumb-bell-shaped or with a constriction giving them a dumb-bell-like form .... 6.
   The coenenchyma spicules are thick, strongly warted spindles. **A. gracillimum** Kükth.
2. The colony consists of a slender, sterile stalk with a number of slender branches .... 3.
   The colony consists of short, thick fleshy branches .... 4.
3. The colony is translucent, the polyps large and hyaline. **A. palmatum** Pallas.
   The colony is slightly transparent, the polyps large.. **A. adriaticum** Kükth.
   The colony is not transparent, the polyps are small, yellow. **A. brioniense** Kükth.
4. The branches are pointed distally and slender.... **A. glomeratum** Hassal.
   The branches are rounded distally, blunt and thick .... 5.
5. The polyps are deep red .... **A. compressum** Stud.
   The polyps are light, hyaline .... **A. digitatum** Linn.

6. The coenenchyma spicules are typically dumb-bell-shaped. The rind spicules always differ in form from the coenenchyma spicules and are never club-shaped........ 7.
   The coenenchyma spicules include no typical dumb-bell-shaped forms, but double cylinders, spheres or disks. The rind spicules, if present, include also clubs........ 11.
7. The rind spicules have a biscuit-like form........ 8.
   The rind spicules are double spheres with short necks........ **A. globuliferum** Klzgr.
8. The twigs of the colony are small and round........ 9.
   The twigs of the colony are large and fingerlike........ 10.
9. The twigs are close-set, flattened against one another and the colony has a brainlike appearance........ **A. sphaerophorum** (Ehrbg.).
   The twigs are somewhat higher and stand somewhat farther apart. **A. digitulatum** Klzgr.
10. The coenenchyma spicules have a short thick neck. **A. pachyclados** Klzgr.
   The coenenchyma spicules have a long neck and small thorns on either end........ **A. brachyclados** (Ehrbg.).
11. Besides other spicules in the coenenchyma there are simple clubs.... 12.
   No clubs in the coenenchyma........ 15.
12. The colony has a distinct stalk........ **A. etheridgei** Thoms. and Mack.
   The colony has no distinct stalk........ 13.
13. The coenenchyma spicules are, in addition to clubs, double spheres with slight constrictions........ 14.
   The coenenchyma spicules consist only of double spheres or dumb-bell-like forms with deep constrictions. The rind spicules are club-shaped........ **A. ceylonense** May.
14. The coenenchyma spicules include thorned spindles.... **A. paessleri** May.
   The coenenchyma spicules include no spindles........ **A. fallax** n. n.
15. The spicules are cylindrical with weak constrictions and slightly thorned........ **A. equisetiforme** n. n.
   The spicules are disklike or warted ovals........ 16.
16. The disklike spicules are beset with inconspicuous warts. **A. fauri** Thoms.
   The disklike spicules are strongly warted........ **A. valdiviae** Kükth.

In der mir vorliegenden Ausbeute von den Philippinen fanden sich Exemplare folgender 3 Arten vor: *Alcyonium pachyclados* Klzgr., *A. digitulatum* Klzgr.; und *A. equisetiforme* n. n., deren Beschreibung ich anbei folgen lasse.

Alcyonium pachyclados Klunzinger. Tafel 1, Fig. 1.

Alcyonium pachyclados KLUNZINGER, Korallt. d. Rot. Meer. 1 (1877) 24, t. l. f. 5; MAY, Jena. Z. 33 (1899) 109, t. 1, f. 13; I. L. HILES, Stolonifera and Alcyonacea, Willey, Zool. Results pt. 4 (1900) 503; HICKSON, Alcyonaria and Hydrocorallia of the Cape of Good Hope (1900) 72; PRATT, Alcyonaria of the Maldives, pt. 2 (1903) 534; Rep. Pearl Oyster Fisheries Manaar 19 (1905) 258; THOMSON und HENDERSON, Alcyonarians from Sansibar (1906) 416; COHN, Alcyonarien von Madagask. u. Ostafrika 2 (1908) 235;

KÜKENTHAL, Fauna S. W. Austral. **3** (1910) 430; THOMSON, Trans. Soc. of Edinburg pt. 3 **47** (1910) 570, t. 2, f. 14, t. 4, f. 33 u. 34; LÜTTSCHWAGER, Arch. f. Naturg. Abt. A, Heft 10 (1914) 20.

Alcyonium elegantissimum MAY, Jena. Z. **33** (1899) 106, t. 1, f. 13.

Alcyonium klunzingeri THOMSON, SIMPSON, HENDERSON, Alcyonarians collected by the Investigator II. The Alcyonarians of the Littoral Area (1909) 2.

Fundorte.—Palawan, Taytay Bay und Shark's Fin Bay (*Light*); Batas Island (*Light*). Mindoro, Sabong Cove, near Port Galera Bay (*Griffin*).

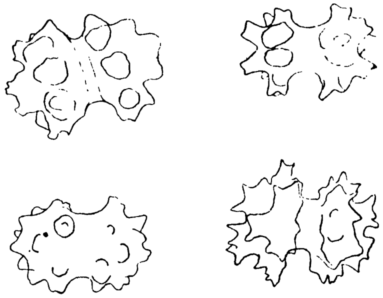

FIG. 1. *Alcyonium pachyclados* Klzgr., Stielskleriten. Vergr. × 200.

Diagnose.—"Von einem kurzen Stiel, der bis auf einen geringen Rest unausgebildet sein kann, erheben sich eine Anzahl Fortsätze. Diese sind dick, oben meist stumpf, breit, fingerförmig, länger als breit, selten mehr kuglig. Sie stehen locker und wenig gedrängt. Die Polypen können ausgestreckt, aber auch ganz zurückgezogen sein. Die Kolonie ist gewöhnlich weich. Die Kalkkörper des Coenenchyms sind grosse, kräftige Doppelkugeln mit zahlreichen zackigen Dornen. Die Mitte der Kalkkörper bildet ein kurzer dornenloser Hals, der Hals ist im allgemeinen nicht eingezogen oder verschmälert. Die Länge der Spicula ist 0.08–010 mm, die Breite 0.06 mm. Die Länge des Halses ist 0.005–0.012 mm. Die Kalkkörper der Rinde sind elliptisch oder achtförmige Gebilde, daneben gibt es auch grössere zylindrische mit Dornen. Länge 0.04–0.05 mm, Breite 0.02 mm."

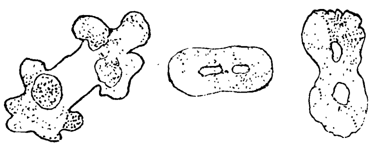

FIG. 2. *Alcyonium pachyclados* Klzgr., Rindenskleriten. Vergr. × 400.

Verbreitung.—Rotes Meer, Malediven, China Straits, Neubritannien, Kap der guten Hoffnung, Golf von Manaar, Tamatave (Ost Madagaskar) Sansibar, Westaustralien, Javasee, Vitiinseln, Nikobaren, Cocosinseln, Andamanen, Luzon (Albay), Mindoro, und Palawan.

Ich folge im wesentlichen Klunzinger und meiner früheren Diagnose (1914). Was ich früher bereits betonte möchte ich hier auch noch einmal hervorheben, nämlich die Variabilität im äusseren Habitus der Kolonien. Ebenso wechselt die Farbe der konservierten Exemplare von weiss bis braun. Die Kolo-

nien haben ein anderes Aussehen, wenn die Polypen eingezogen, ja tief versteckt sind, wie es bei dem früheren *A. klunzingeri* der Fall ist, das ja auch in den Formenkreis von *pachyclados* gehört—ein anderes Aussehen, wenn die Polypen nicht zurückgezogen sind, sondern alle Aeste überziehen wie Blüten. Auch die Härte der Exemplare ist verschieden. Am härtesten sind die Kolonien deren Polypen ganz zurückgezogen sind, so dass fast eine netzförmige Struktur entsteht, wie *A. klunzingeri* sie zeigt. Diese Kolonien haben auch den kürzesten Stiel, sie sind mit kleiner Basis angeheftet, der kurze Stiel erweitert sich sehr rasch und trägt die kurzen Fortsätze. Eine geringe Basalanheftung scheint mir überhaupt characteristisch für diese Art zu sein und ebenso die schnelle Verbreitung des Stieles. Je nachdem wird die Kolonie höher oder bleibt niedrig, fast inkrustierend. Die fingerförmigen Fortsätze sind bei den meisten Exemplaren 3–4 cm lang, nur bei einem meiner Exemplare sind sie bis 5 cm lang. Die mir vorliegenden Exemplare von den Philippinen ähneln dem *A. elegantissimum* May, das ich auch zu *A. pachyclados* stelle. Bei dieser Form sind die fingerförmigen Fortsätze etwas schmaler und länger als gewöhnlich. Diese Verschiedenheiten im Bau hängen meiner Ansicht nach von den Standortsverhältnissen ab und sind nur als solche zu bewerten. Mir erscheint die Form und Grösse der Spicula, die bei allen die gleiche ist, als das wertvollere Characteristicum der Art. Auch die übrigen Bearbeiter dieser Art heben deren Variabilität hervor.

Alcyonium digitulatum Klunzinger. Tafel 1, Fig. 2.

Alcyonium digitulatum KLUNZINGER, Korallt. d. rot. Meer. 1 (1877) 24, t. 1, f. 3; COHN, Alcyonarien von Madagask. u. Ostafr. 2 (1908) 236; LÜTTSCHWAGER, Arch. Naturg. Abt. A. Heft 10 (1914) 24.

Fundort.—5 Exemplare. "From shallow reefs at Batas Island on the east coast of Palawan." (*Light.*)

Diagnose.—"Ein kurzer Stiel verzweigt sich in eine Anzahl von Lappen, die ihrerseits Läppchen bilden; diese stehen nicht so dicht wie bei *A. sphaerophorum,* sind meist kurz, fingerförmig, schmal, etwas länger wie breit. Die Polypen sind meist nicht ganz zurückgezogen, so dass die Kolonie wollig erscheint. Die Rindenspicula sind bis 0.05 mm grosse, 0.016 mm breite, längliche Ellipsen mit oder ohne helleren Hals, meist ohne deutliche Einschnürung. Die Coenenchymspicula der Scheibe haben meist einen langen Hals, der aber nicht verschmälert zu sein braucht, und wenige grosse Dornen an beiden Enden. Die Coenenchymspicula des Stieles haben einen kurzen Hals, der stark eingezogen

ist. Die Enden der Spicula sind dann zu grossen Köpfen erweitert. Die Länge der Spicula ist 0.07–0.08 mm, die Breite der Köpfe beträgt bis 0.06 mm. Die Farbe der Kolonie ist grauweiss, die Polypen sind dunkler. Die Consistenz ist lederartig."

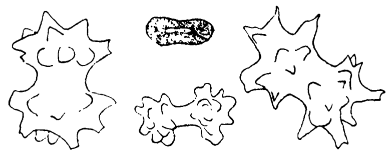

Fig. 3. *Alcyonium digitulatum* Klzgr., Rinden- und Stielskleriten. Vergr. × 200.

Verbreitung.—Rotes Meer, Kokotari (Sansibar), Batas Insel (Palawan). Durch die mir vorliegenden 5 Exemplare kann ich Klunzingers Angaben bestätigen, während mir bei meiner ersten Revision kein Material vorlag. Diese Art hat in ihren Spicula eigentlich nichts sehr characteristisches, dafür unterscheidet sie sich, wie ich an den mir vorliegenden Exemplaren feststellte, durch ihren Habitus von den übrigen Arten. Der Habitus ist doch derartig, dass er sich nicht in den Formenkreis einer anderen Art einfügen lässt. Zu bemerken ist noch, dass neben vielen Rindenspicula ohne hellere Mitte auch einige vorkommen die diese besitzen.

Alcyonium equisetiforme n. n. Tafel 1, Fig. 3.

Alcyonium paessleri May, Alcyon. Ergeb. Hamburg. Magulh. Sammelreise (1899) 6; Hickson, Nat. antract. Exp. nat. hist. **3** (1907) 3, t. 2, f. 22, 23.

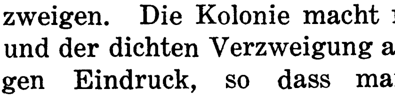

Fig. 4. *Alcyonium equisetiforme* n. n., Rindenskleriten Vergr. × 200.

Fundorte.—Mindoro, Port Galera Bay, 8 Exemplare (*Light*).

Diagnose.—"Von einem dicken runden Stamme gehen einige wenige Aeste ab, die sich in runde, etwa 3 cm lange, fingerförmig zugespitzte Fortsätze verzweigen. Die Kolonie macht mit ihrem dicken, langen Stamm und der dichten Verzweigung am oberen Ende einen baumförmigen Eindruck, so dass man deutlich einen Stamm und eine Krone unterscheiden kann. Die Polypen stehen vereinzelt auch an dem oberen Ende des Stammes. Die Spicula sind hauptsächlich auf den Stamm beschränkt. Bei den grösseren Formen haben sie die Form einer Walze, die an beiden Enden zugespitzt ist. Eine schwache Einschnürung in der Mitte deutet auf die typische Alcyoniumform hin. Die Walzen sind

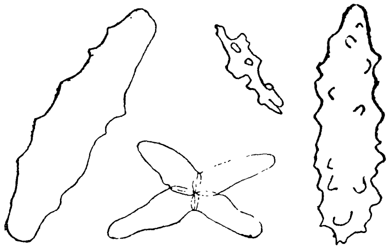

Fig. 5. *Alcyonium equisetiforme* n. n., Stielskleriten. Vergr. × 200.

unregelmässig, aber dicht bewarzt, meist 0.1–0.2 mm lang und 0.06 mm breit. Im Coenenchym der Zweige liegen wenige schmale Stäbe. Die Konsistenz der Kolonie ist weich während der Stamm fester ist. Die Farbe der Alkoholexemplare ist gelb bis bräunlich."

Verbreitung.—Franklin Insel, Antarctik, Port Galera Bay, Mindoro. Wie ich bereits oben angeführt habe, rechne ich meine Exemplare zu der von Hickson *A. paessleri* gestellten Art. Meine kleineren Exemplare haben schmale Spindeln, wie sie auch Hickson beschreibt; die grossen besitzen dickere, stärkere walzenartige Spicula.

Von den andern, in der Ausbeute nicht vertretenen Arten sollen nur die verbesserten Diagnosen nebst kurzen Bemerkungen gegeben werden.

Alcyonium digitatum Linnæus.

Alcyonium digitatum LINNÆUS, Syst. Nat. ed. 10 1 1758) 803; ELLIS und SOLANDER, Zooph. (1786) 175, pl. 1, fig.; JOHNSTON, Hist. British Zooph. (1847) 174, pl. 34; MILNE-EDWARDS, Hist. Nat. Corall. 1 (1857) 118; STORM, Norske Selsk. Skr. 1884 (185) 45; Oversigt over Trondjemfjordens Fauna (1901) 3; HICKSON, Quart. Journ. Micr. Sci. London n. s. 37 (1895) 343, Alcyonium (1901) 92; The Alcyonarian, Bay of Biscaya (1907) 7; ROULE, Résult. scient. de la campagne du Caudan (1896) 306; NORDGAARD, Hydrogeographical and biological investigations in Norwegian fjords (1905) 158; (pars) Nordgaard. Mofjordens Naturforhold (1907) 19; PRATT, The digestive organs of the Alcyonaria and their relation to the mesogloeal cell plexus (1905); KÜKENTHAL, Alcyonaria der deutschen Tiefsee-Exp. 13 (1906) 42; STEPHENS, Alcyonarian and madreporarian corals of the Irish coast (1909) 4; BROCH, Die Alcyonarien des Trondjemfjordes, I. Alcyonacea. Norske Selsk. Skr. 1911 (1912) 27.

Diagnose.—"Die Kolonien sind rund, fest, dick, fleischig und aufrecht stehend, oft handförmig in einer Ebene verzweigt, und vollkommen mit Polypen bedeckt. Die ausgestreckten Polypen sind gross und hyalin. Die Coenenchymspicula sind meist kreuzförmig gestaltete, auch weiter verzweigte, schlanke Spindeln, mit locker stehenden langen Dornen, durchschnittlich 0.2 mm lang.

"Die dicht liegenden Rindenspicula zeigen eine hantelförmige Ausbildung, die häufig durch sehr kräftige und verzweigte rauhe Warzen verwischt ist, so dass sie ebenfalls kreuzförmig erscheinen können. Sie sind durchschnittlich 0.06–0.07 mm lang.

"Die Polypen sind mit 8 Reihen locker liegender, schmaler Spicula bewehrt, die schwach bedornt sind und meist eine Länge von 0.2 mm haben. Diese Spiculabewehrung erstreckt sich vom oberen Teil des Schlundrohres bis in den Grund der Tentakel. Farbe der Kolonie orange bis weisslich."

Verbreitung.—Europäische Meere, in der littoralen und in den oberen Teilen der abyssalen Region.

Alcyonium compressum Th. Studer.

Alcyonium glomeratum STUDER, Note préliminaire sur les Alcyon. de l'Hirondelle 4 (1891) 555.

Alcyonium compressum STUDER, Alyconaires de l'Hirondelle, fasc. 20 (1901) 22, tab. 3, fig. 1.

Diagnose.—"Die Kolonie hat die Form eines lamellenartigen Blattes, von dem sich abgeplattete und gerundete Lappen bis zu einer Höhe von 42 mm erheben. Die Oberfläche der Lappen ist hart und ledern. Die Polypen sind vollkommen zurückziehbar. An der ganzen Oberfläche des Polypariums liegen kräftige Spicula in Form von dornigen Keulen, von Spindeln mit langen Dornen und einigen verzweigten, unregelmässigen bedornten Körpern eine harte lederartige Rinde. Die Länge der Spicula beträgt 0.72–0.1 mm, ihre Dicke 0.01–0.03 mm. Die Coenenchymspicula sind lange, gerade oder gekrümmte Stäbe, mit kurzen und entfernt stehenden Dornen besetzt, von 0.21–0.3 mm Länge. In den Tentakeln befinden sich Spindeln mit starken, rotgefärbten Dornen von 0.12 mm Länge, 0.03 mm Dicke, neben kleineren ungefärbten Stäbchen. Die Farben der Kolonie ist fleischrot, die der Tentakel und des zurückziehbaren Teiles der Polypen ist intensiv rot."

Verbreitung.—Golf von Biscaya.

Studer hat in seiner "Note préliminaire sur les Alcyon. de l'Hirondelle" diese Art zuerst mit *Alcyonium glomeratum* Hassall identifiziert, schreibt dann aber zum Schlusse, dass seine neue Art zwar verwandt scheine dem *Alcyonium glomeratum* Hassall (*Rodophyton couchii* Gray) durch seine harte Rinde, doch bilde die letztere Art fingerförmige, zylindrische Lappen, besonders bei dem Exemplar das für Gray den Typus seiner *Rodophyton couchii* darstelle. Bei dieser Art seien auch die Kelche viel mehr hervorstehend, "striés et quelquefois adhérents par un côte de leur paroi au coenenchym de sorte qu'ils ont la forme d'un nid d'hirondelle." Diese Eigenschaft, die besonders in der Abbildung Grays betont sei, erscheine weniger in der Abbildung von *A. glomeratum,* die Hickson gab. Die Spicula, die zum ersten Male durch Hickson dargestellt seien, "sont assez différents de ceux de notre espèce." Studer identifiziert also Hicksons *A. glomeratum* doch nicht mit seinem *A. compressum* und hat darin Recht; denn nach seiner Zeichnung und Beschreibung ist es eine andere Art, wenngleich ja leider jede Spiculazeichnung fehlt. Mir scheint es, dass *A. compressum*

Stud. wie *A. glomeratum* Hassall sich nahe an *A. digitatum* L. anschliessen.

Alcyonium glomeratum Hassall.

Alcyonium glomeratum HASSALL, Ann. & Mag. Nat. Hist. **11** (1843) 112; JOHNSTON, Hist. British Zooph. (1847) 178; HICKSON, Quart. Journ. Micr. Sci. London n. s. **37** (1895) pl. 4, non *Alcyonium glomeratum* Hiles, in Willey, Zool. Results pt. 4 (1900) 503; STUDER, Note préliminaire sur les Alcyon. de l'Hirondelle **4** (1891) 555.
Alcyonium sanguineum COUCH, The Cornish Fauna (1843) 60, Taf. 13, fig. 1.
Rodophyton couchii GRAY, Proc. Zool. Soc. London (1865) 706.

Diagnose.—"Die Kolonie ist ähnlich gebaut wie *A. digitatum*, unterscheidet sich jedoch von ihr dadurch dass die Lappen mehr zugespitzt, schlanker und tiefer geteilt sind und locker stehen. Die Polypen können zurückgezogen oder ausgestreckt sein. Die roten Spicula sind schmale bedornte Spindeln von 0.2–0.4 mm Länge, und Keulen, die am schmalen Ende schwach, oben stärker bedornt sind. Die Farbe der Kolonie ist gelbrot."

Verbreitung.—Küsten Gross-Britanniens, Norwegen; Talili-Bai, Neu-Britannien (?).

Wie Hickson schon ausführte, ist auf die Tatsache, dass die Polypen ausgestreckt oder zurückgezogen sind, kein Gewicht zu legen; denn dies kann verschiedene uns unbekannte Gründe haben. Dagegen sind der abweichende Bau, die meist tiefrote Farbe der Kolonie und die anders als bei *A. digitatum* gebauten Spicula ein wesentliches Unterscheidungsmerkmal der beiden Arten.

Alcyonium palmatum Pallas.

Alcyonium palmatum PALLAS, Elench. zooph. (1766) 349; LAMOUROUX, Hist. des polyp. corall. (1816) 335; DANA, Zooph. (1846) 615; M. SARS, Bidrag til Kundsgaben am Middelhavets Littoralfauna, Reisebemaerkninger fra Italien (1857) 3; KÖLLIKER, Icon. Hist. (1865) 132; v. KOCH, Mitt. Zool. Stat. Neapel. **9** (1891) 663; KÜKENTHAL, Jena. Z. **42** (1906) 62.
Lobularia palmata LAMARCK, Hist. Nat. An. s. vert. **2** (1816) 214; EHRENBERG, Korallt. d. Rot. Meeres (1834) 282.
Lobulaire palmé BLAINVILLE, Man. Actin. (1834) 522.

Diagnose.—"Von einem im unteren Teile sterilen, meist säulenförmig hochgewachsenen Stamme gehen eine Anzahl zierlicher, schlanker, runder Aeste ab, die rings mit—im ausgestreckten Zustande bis 8 mm langen—Polypen besetzt sind. Diese Hauptäste senden noch Nebenzweige ab, doch stehen alle locker und sind nicht gleich lang, so dass der polypentragende Teil der Kolonie an keiner Stelle einen gedrängten oder dichten

Eindruck macht. Von Spicula kommen in der Rinde erstens Gebilde vor, deren Hantelform verwischt ist und die mehr Doppelkreuzen gleichen, das heist, einem Stabe, der mit zwei Dornenkränzen versehen ist. Ihre Länge beträgt durchschnittlich 0.06 mm. Ferner kommen grössere, plumpere Spicula vor, die unregelmässig bedornt sind. Im Coenenchym liegen 0.2 mm lange, ganz schmale, schwach bedornte Nadeln. Die Farbe der Kolonie ist gelblich, gelb bis orange, der Stiel kann auch ganz rot erscheinen. Die Farbe wird durch die gefärbten Spicula erzeugt. Die Polypen sind mit schmalen, schwach bedornten, bis 0.4 mm langen Nadeln bewehrt, die sich, dicht liegend, bis in die Tentakel erstrecken."

Verbreitung.—Mittelmeer.

Alcyonium brioniense Kükenthal.

Alcyonium brioniense KÜKENTHAL, Jena. Z. 42 (1906) 61, t. 4.

Diagnose.—"Die Kolonien sind kleiner als die von *A. palmatum.* Von einem dicken, langen, sterilen Stammteile gehen wenige kurze Zweige ab. Die gesamte Kolonie ist undurchsichtig. Die hellgelben Polypen sind klein, halb so gross wie bei *A. palmatum.* Die Tentakel sind am Grunde breit und werden nach oben spitz, die untersten Pinulä sind sehr lang, die obersten kurz. Die Farbe der Kolonie ist dunkelpurpurrot mit hellgelben Polypen. Die Wandung der Polypen ist sehr dicht mit transversalen Spicula bedeckt. Diese konvergieren nach oben und treten in die Achse der Tentakel ein. Sie sind schlanker als bei *A. palmatum* und bis 0.24 mm lang. In der Rinde der Aeste liegen kleine plumpe Spicula von 0.06–0.12 mm Länge, mit wenigen grossen Dornen besetzt. In der Stammrinde sind bis 0.15 mm lange plumpe Spindeln. Im Coenenchym liegen gestrecktere, schlankere Formen von 0.25 mm Länge mit wenigen grossen Dornen versehen. Die Spicula haben fast stets rote Farbe. Die Farbe der Kolonie ist stets dunkelrot mit gelben Polypen."

Verbreitung.—Brionische Inseln.

Alcyonium adriaticum Kükenthal.

Alcyonium palmatum forma *adriatica* KÜKENTHAL, Jena. Z. 42 (1906) 70.

Alcyonium adriaticum KÜKENTHAL, Beob. an einigen Korallentieren d. adriatischen Meer. Aus der Natur (1909) 323.

Diagnose.—"Die Verzweigung ist plumper als bei *A. palmatum* und erfolgt meist in einer Ebene (manus marina). Die Kolonie ist nicht so durchscheinend wie *A. palmatum* aber

durchsichtiger als *A. brioniense*. Die Polypenstellung ist dieselbe. Die Spicula der Stammrinde sind breite flache Platten, 0.12 mm lang, 0.06 mm breit, mit wenigen abgeflachten breiten Dornen. Die Spicula des oberen Teiles der Kolonie sind sehr ähnlich denen von *A. palmatum*. Farbe meist ockergelb bis orange-gelb."

Verbreitung.—Nördliches adriatisches Meer.

Alcyonium brachyclados (Ehrenberg).

Alcyonium tuberculosum QUOY und GAIMARD, Voy. Astrolabe (? 1833) 274, t. 23, f. 4 und 5.

Lobularia brachyclados EHRENBERG, Korallt. d. rot. Meer. (1834) 282.

Alcyonium brachyclados DANA, Zooph. (1846) 617; KLUNZINGER, Korallt. d. rot. Meer. 1 (1877) 25, t. 1, f. 4; COHN, Alcyonarien von Madagaskar u. Ostafrika (1908) 234; LÜTTSCHWAGER, Arch. Naturg. Abt. A, Heft 10 (1914) 22.

Diagnose.—"Der Habitus ist derselbe wie *A. pachyclados*. Die Coenenchymspicula sind jedoch schlank, langhalsig mit wenig verbreitertem Kopfe, gleichen mehr an beiden Enden bestachelten Zylindern als Doppelkeulen. Die Rindenspicula sind trübe Ellipsen oder mehr hantelförmige Gebilde ohne hellen Hals und sind 0.05 bis 0.06 mm lang, 0.02 bis 0.03 mm breit. Die Coenenchymspicula sind 0.06 bis 0.08 mm lang, 0.02 bis 0.05 mm breit. Die Farbe der konservierten Exemplare ist dunkelgraugrün, die Consistenz der Kolonie ist weich."

Verbreitung.—Rotes Meer, Tamatave, Tonga?

Die von Klunzinger aufgestellte var. *elongata* unterscheidet sich von der Stammform durch längere, mehr fingerförmige Läppchen, stimmt aber in der Gestalt der Kalkkörper ganz mit dem typischen *A. brachylados* überein. Wie ich bereits ausführte, hat Whitelegge eine von ihm beschriebene neue Sinulariaart zu Unrecht mit *A. tuberculosum* Q. u. G. identifiziert das er zu *Lobophytum* stellt; dazu bemerke ich folgendes.

Alcyonium tuberculosum Q. u. G. ist warhscheinlich ? *Alcyonium brachyclados; Lobophytum tuberculosum* Whitelegge ist *Sinularia whiteleggei* Lüttschwager.[3] Der Name *A. tuberculosum* Q. u. G. ist zwar älter als *A. brachyclados* (Ehrbg.), trotzdem ist der letztere Name beizubehalten; denn bei dem Mangel jeglicher Spiculaabbildung bezüglich Beschreibung kann diese Art Quoy und Gaimards nicht als "ausreichend beschrieben" bezeichnet werden.

[3] Lüttschwager, Arch. f. Naturg. Abt. A, Heft 10 (1914) 13.

Alcyonium sphaerophorum (Ehrenberg).

Lobularia sphaerophora EHRENBERG, Korallt. d. rot. Meer. (1834) 57.
Alcyonium sphaerophorum DANA, Zooph. (1846) 616, Synopsis (1859) 123; MILNE-EDWARDS, Hist. Nat. Corallt. 1 (1857) 119; KLUNZINGER, Korallt. d. rot. Meer. 1 (1877) 22, t. 1, f. 1; MAY, Jena. Z. 33 (1902) 105; COHN, Alcyonarien von Madagaskar u. Ostafr. 2 (1908) 231; THOMSON und RUSSELL, Alcyonar. coll. on the Percy Sladen Trust exp. by J. Stanley Gardiner (1910) 174; LÜTTSCHWAGER, Arch. Naturg. Abt. A, Heft. 10 (1914) 23.
Cladiella sphærophora GRAY, Ann. & Mag. Nat. Hist. III 3 (1869) 125.

Diagnose.—"Die Kolonie ist halbkugelig, mit niederem breitem Fuss. Die Lappen sind flach kugelig, stehen dicht gedrängt, so dass sie sich gegenseitig abplatten, sind breiter als hoch und haben so dass Aussehen von Gehirnwindungen. Die Lappen sind Gruppen einer Anzahl von Läppchen und sind 15–20 mm breit. Die Rindenspicula sind kleine, schmale sogenannte Biskuitformen mit hellem Fleck in jeder Hälfte. Die Coenenchymspicula sind stachelige Doppelkeulen mit nackter Einschnürung. Ihre Länge ist 0.03–0.06 mm, ihre Breite 0.015–0.03 mm. Die Farbe der konservierten Kolonien ist weissgrau."

Verbreitung.—Rotes Meer, Tubar Riff (S. W. Madagaskar), W. Australien, Talili, Praslin, Seychellen.

Alcyonium sphaerophorum var. **sansibaricum** Cohn.

Alcyonium sphaerophorum var. *sansibaricum* COHN, Alcyonarien von Madagaskar u. Ostafr. 2 (1908) 233; LÜTTSCHWAGER, Arch. Naturg. Abt. A, Heft 10 (1914) 24.

Diagnose.—"Im allgemeinen ist die Kolonie so gebaut wie *A. sphaerophorum,* jedoch sind die einzelnen Läppchen relativ grösser wie bei der Stammform. Diese erheben sich auf sehr kurzem, sterilem Stiele, zumeist gesondert, ohne sich zu Bündeln zu vereinigen. An der Oberfläche zeigen sie dasselbe Bild wie *A. sphaerophorum.* Die Kolonie hat ein blumenkohlartiges Aussehen. Die Polypen sind meist vollkommen zurückgezogen. Die Spicula sind im wesentlichen die gleichen wie bei *A. sphaerophorum,* zeigen deren Hantelform und zeichnen sich durch grosse Helligkeit aus. Die Farbe und Consistenz ist dieselbe wie bei *A. sphaerophorum.*"

Verbreitung.—Sansibar.

Ich gebe diese Diagnose nach der Beschreibung Cohns. Aus ihr ist zu ersehen, dass er den Habitus der Kolonie als das einzige Unterscheidungsmerkmal angesehen hat; denn die Abweichungen im Bau der Spicula sind zu unbedeutend. Wir

haben es hier mit einer Form zu tun, die sich eng an die Stammform anschliesst, vielleicht auch nur eine Standortsvarietät ist.

Alcyonium globuliferum Klunzinger.

Lobularia sphaerophora TARGIONI-TOZZETTI, Atti Soc. Ital. **15** (1872) 4.
Alcyonium globuliferum KLUNZINGER, Korallt. d. rot. Meer. Teil 1 (1877) 23, t. 1, f. 2; LÜTTSCHWAGER, Arch. Naturg. Abt. A, Heft. 10 (1914) 23.

Diagnose.—"Das Aussehen der Kolonie erscheint gehirnartig, indem einander abplattende, flachkugelige, kurze Lappen und Läppchen in deutlicher Gruppierung mit engen Furchen sich zwischen den Läppchen finden, welche oft wie eingeschnürt erscheinen. Die Läppchen sind selten über 4–6 mm breit und 2–4 mm hoch. Jede Läppchengruppe sitzt auf einem sterilen Stiel von 0.5–1 cm Höhe, welcher dem gemeinsamen Fuss der Kolonie aufsitzt. Die grösseren Läppchengruppen oder Lappen sind 2–3 cm breit. Die Kolonie ist an der Oberfläche etwas gewölbt. Die Rindenspicula sind dornlose Doppelkugeln mit sehr deutlichem, schmalerem und helleren aufgesetztem Hals, ihre Länge ist 0.040–0.056 mm, ihre Breite 0.025 mm. Die Coenenchymspicula sind Hanteln mit dornenlosem kaum verschmälertem Hals. An ihren Enden stehen starke, stumpfe Dornen und Höcker, die auch zugespitzt sein können. Ihre Länge ist 0.06–0.10 mm, ihre Breite 0.05 mm."

Verbreitung.—Rotes Meer.

Alcyonium ceylonense May.

Alcyonium ceylonense MAY, Beitr. z. System. u. Chorologie d. Alcyonaceen, Jena. Z. **33** (1899) 109; LÜTTSCHWAGER, Arch. Naturg. Abt. A, Heft 10 (1914) 25.
Alcyonium ceylonicum PRATT, Report on the pearl oyster fisheries of the Gulf of Manaar (1905) 257.

Diagnose.—"Die Kolonie bildet derbe, fleischige Massen, deren Rand aufwärts gebogen ist. Auf der Oberfläche stehen wenige, zerstreute, oft hahnenkammartige gefaltete Lappen. Die Rindenspicula sind reich mit Warzen besetzte Keulen und Stäbe. Die Coenenchymspicula sind sehr stark eingeschnürte Doppelkeulen mit stark entwickelten und mit vielen bedornten Warzen besetzten Enden. Die Einschnürung ist 0.06 mm breit. Die Länge der Spicula ist 0.285 mm (0.14–0.1 mm nach Pratt)."

Verbreitung.—Ceylon, Riff bei Galle.

Die Farbe der Kolonie wird von May als braun angegeben, von Pratt als cremeweiss. Wie bei *A. pachyclados* scheint sie auch bei dieser Art zu wechseln.

Alcyonium etheridgei J. A. Thomson und D. L. Mackinnon.

Alcyonium etheridgei THOMPSON und MACKINNON, Alcyonarians of the Thetis Exp., Mem. Mus. Austr. 4 [13] (1911) 166, pl. 61, f. 2 u. 3, pl. 62, f. 3, pl. 67, f. 4, pl. 69.

Diagnose.—"Von einer leicht inkrustierenden Basis erhebt sich ein kräftiger Stiel. Dieser ist sehr fest und hat eine ziemlich rauhe, faltige Oberfläche. Der Stiel teilt sich in eine Anzahl kräftige, fingerförmige Lappen von 1–2 cm Durchmesser. Diese Lappen teilen sich weiter in neue von gewöhnlich 0.5–0.75 cm Höhe, mit einem Durchmesser von 1.75 cm Höhe. Die ganze Oberfläche erscheint dicht besetzt mit weissen Spicula. Diese sind derbe Doppelkeulen mit abgesetztem Hals und mit zwei Kränzen von vorspringenden Warzen. Ihre Länge ist 0.08–0.18 mm, ihre Breite 0.08–0.11 mm; jedoch gibt es auch kleinere Formen. Die Spicula der Polypen sind Spindeln und Keulen von dünner Form mit einigen vorspringenden Warzen von 0.17–0.30 mm Länge. Die Farbe der Kolonie ist graubraun bis dunkelbraun, die Polypen sind dunkler."

Verbreitung.—Manning Bight.

Alcyonium paessleri May.

Alcyonium paessleri MAY, Alcyonar. Erg. Hamburg. Magalh. Sammelr. (1899) 6 u. 7, Fauna arctica 1 (1900) 403; HICKSON, Nat. Antarct. Exp. Nat. Hist. 3 (1907) 3, t. 2., f. 22, 23.

Diagnose.—"Die unregelmässig gestaltete Kolonie besteht aus einer langgestreckten, stellenweise zu kugeligen Wülsten angeschwollenen Coenenchymmasse, auf der sich konische Papillen erheben, in die die Polypen vollständig zurückziehbar sind. Basalteil und Lappen sind nicht deutlich von einander abgesetzt. Die Rindenspicula sind stark bedornte Keulen von 0.07–0.14 mm Länge. Die Coenenchymspicula sind bis 0.21 mm lange Spindeln und Stäbe mit langen, locker stehenden Dornen. Die Polypenspicula sind spindelförmig, 0.42 mm lang, 0.035 mm breit, mit kürzeren und dichter stehenden Dornen versehen als die Coenenchymspicula. Die Farbe der Alkohol-exemplare ist durchweg weisslich."

Verbreitung.—Smyth Kanal.

Nicht identisch mit *A. paessleri* May sind die von Hickson 1902 und 1907 beschriebenen Exemplare. May beschreibt *A. paessleri* als eine unregelmässig gestaltete Kolonie, die aus einer langgestreckten, stellenweise zu kugeligen Wülsten angeschwollene Coenenchymmasse besteht, auf der sich konische Papillen

erheben. Ganz anders lautet Hicksons Beschreibung, nämlich, "es erheben sich 13 stumpfe Lappen." Mir liegen 8 Exemplare von den Philippinen vor. Diese zeigen nun einen solchen Habitus wie ihn Hickson beschreibt und wie sich aus Hicksons Abbildung erkennen lässt. Hickson lagen offenbar junge Exemplare einer andern Art vor. Das kleinste meiner Exemplare zeigt die Spiculaform wie Hicksons *A. paessleri*. Die grösseren Exemplare zeigen stärkere Spicula, die mehr Walzenform mit einer Einschnürung annehmen. Ich halte daher nach meinem Befinden, Hicksons Art für nicht identisch mit Mays *A. paessleri*. Sie müssen auseinander gehalten werden und Hicksons Art muss deshalb einen neuen Namen erhalten. Ich nenne sie, weil die Aeste der fertilen Sprossen der Gattung *Equisetum* sehr ähnlich sehen, *Alcyonium equisetiforme*.

Alcyonium fallax n. n.

Alcyonium purpureum HICKSON, Alcyonaria of the Cape of Good Hope, pt. 2 (1904) 215, t. 7, f. 1, t. 9, f. 18; THOMPSON, Trans. Roy. Soc. Edinburgh, pt. 3 (Nr. 19) 47 (1910) 566, pl. 3, f. 16, pl. 4, f. 24 und 25; LÜTTSCHWAGER, Arch. Naturg. Abt. A, Heft 10 (1914) 26.

Diagnose.—"Die Kolonie besitzt weder Stamm noch Stiel. Von einer inkrustierenden Scheibe erheben sich eine Anzahl Lappen. Die Polypen zeigen auf den Lappen die Tendenz, sich spiralig anzuordnen, sie sind vollständig zurückziehbar, oft aber ausgestreckt. Die Spicula der Basalverbindung sind stark eingeschnürte Hantelformen mit einigen grossen Dornen und Warzen. Ihre Länge ist 0.08 bis 0.12 mm und ihre Breite 0.08 bis 0.09 mm. Die Rindenspicula sind Spindeln, Kugeln, Doppelkugeln, und Doppelkeulen mit vorspringenden Warzen. Die Spindeln haben eine Länge von 0.08–0.2 mm, die Kugeln und Doppelkugeln 0.11–0.17 mm, die Keulen und Doppelkeulen von 0.08–0.14 mm. Die Coenenchymspicula sind Kugeln und Doppelkugeln von 0.1–0.3 mm Länge. Die Polypenspicula sind Spindeln (0.10–0.11 mm Länge), Kugeln, Doppelkugeln und Keulen. Die Farbe der Kolonie ist prächtig rot."

Verbreitung.—Morsel Bay, Kap Kolonie, und zwischen Roman Rock und Kap Recife.

Der Name *A. purpureum* ist bereits von Lamarck vergeben worden und zwar für eine Form die wohl als Schwamm anzusprechen ist. Nach den bestehenden Nomenklaturregeln muss deshalb der Name geändert werden, und ich wähle dafür die Bezeichnung *A. fallax*.

Alcyonium valdiviae Kükenthal.

Alcyonium valdiviae KÜKENTHAL, Alcyonaria der deutschen Tiefsee-Exp. (1906) 42, t. 3, f. 11, t. 8, f. 39–41.

Diagnose.—"Der massige Stamm sendet einige kurze, plumpe Hauptäste ab, von deren oberem Teile zahlreiche, kurze, konisch geformte Endäste nach allen Richtungen entspringen, diese verjüngen sich nach oben und enden stumpf konisch. Die Polypen sind sämtlich zurückezogen und erscheinen als kleine flache Warzen; sie treten auch auf den Hauptstamm über. Die Oberfläche der Kolonie ist matt, fast rauh. Die Rindenspicula liegen dicht angeordnet, sind meist rötlich gefärbt und mit zwei Gürteln sehr grosser Dornen versehen, im allegemeinen Umriss ovale Körper von 0.04 mm Länge. Coenenchymspicula finden sich nur im Stamm in ähnlicher Form wie sie die Rindenspicula zeigen, von 0.04 mm Länge."

Verbreitung.—Agulhasbank.

Alcyonium fauri J. A. Thomson.

Alcyonium fauri THOMSON, Trans. Roy. Soc. Edinburg pt. 3 (Nr. 19) 47 (1910) 568, t. 1, f. 5, t. 4, f. 44.

Diagnose.—"Die Kolonie ist inkrustierend und besteht aus einer ziemlich harten, kompakten Masse mit nahestehenden, polypentragenden Lappen. Jeder Lappen hat mehr oder weniger halbkreisförmige Form. Die Polypen stehen kontinuierlich im weichen Coenenchym. Die Lappen haben keine Stiele, sondern kommen aus gemeinsamer, horizontaler inkrustierender Scheibe. Diese basale Scheibe ragt an einzelnen Stellen über den Basisrand der Polypenlappen hinaus und ist mit zahlreichen Spicula bedeckt. Die Zahl der Lappen beträgt über 20. Die Kolonie misst 41 mm Länge, 32 mm Breite, und 9.5 mm Höhe. Die Zahl der Polypen in den Lappen ist sehr verschieden. Ein grosser Lappen ist 11 mm lang, 11 mm breit, und 9 mm hoch. Die Polypen sind zahlreicher und besser am Rande als im Mittelpunkt der Lappen ausgebildet. Die Polypen können ausgestreckt aber auch ganz zurückgezogen sein; ausgestreckte ragen über 3 mm über die Oberfläche hervor. Spicula befinden sich im Basalteil und im Coenenchym an der Polypenbasis. Im Innencoenenchym fehlen sie. Sie haben die Form von Hanteln mit ganz schwacher Einschnürung, sind 0.09–0.12 mm lang und 0.06–0.09 mm breit. Die Farbe ist hellbraun."

Verbreitung.—Kap St. Blaize.

Alcyonium gracillimum Kükenthal.

Alcyonium gracillimum KÜKENTHAL, Zool. Anz. **30** (1906) 284, Japan. Alcyonac., Abh. K. Bayr. Ak. Wiss. II. Kl. Suppl. 1 (1906) 34, t. 2, f. 13; NUTTING, Proc. U. S. Nat. Mus. **43** (1913) 21.

Diagnose.—"Von der lederigen membranösen Basis erhebt sich ein sehr dicker, walzenförmiger, steriler Stiel, der einige plumpe Seitenäste abgibt, die mit Polypen besetzt sind. Die Polypen stehen in kleinen rundlichen Bildungen von 2 mm Durchmesser zusammen. Diese stehen am Hauptstamm mehr vereinzelt, an den kurzen Aesten dagegen eng zusammen und bilden so grössere blumenkohlartige Gebilde. Die Polypen sind vollkommen zurückgezogen. Die Polypen besitzen Spicula in der Form von etwas gekrümmten Spindeln, die mit hohen runden Dornen besetzt sind. Ihre Länge ist 0.3 mm. In der Stammrinde finden sich etwas dickere, meist gebogene Stäbe von 0.25 mm durchschnittlicher Länge mit grösseren, sehr weit stehenden Dornen. Die Coenenchymspicula sind 0.6 mm lange, dicke Spindeln mit grossen, gezackten Warzen, Meist sind sie in der Mitte etwas eingeschnürt. Die Farbe der Kolonie ist gelbbraun."

Verbreitung.—Sagamibucht, Misaki.

SPECIES DUBIÆ

Alcyonium rotiferum J. A. Thomson.

Alcyonium rotiferum THOMSON, Trans. Roy. Soc. Edinburgh pt. 3 (Nr. 19) 47 (1910) 373, pl. 1, f. 3 u. 4, pl. 4, f. 38.

Diagnose.—"Die Kolonie besteht aus einer Anzahl dünner, zylindrischer Lappen, die sich an ihrer Basis miteinander vereinigen. Die Lappen gehen zuweilen in schmalere Lappen und Läppchen über. Die Basis der Stiele ist leicht einwärts gebogen. Die Rinde der Kolonie ist zäh und lederartig und birgt zahlreiche Spicula. Die Oberfläche des Stieles und des polypentragenden Teiles ist durch characteristische Falten gekennzeichnet, die sich in verschiedene Felder teilen und ihr ein runzeliges Aussehen geben. Die Spicula haben die Form von Doppelrädern."

Verbreitung.—Kuskamma.

Mir erscheint die Art als nicht zu *Alcyonium* gehörig, und zwar einmal der Wuchsform wegen—die Kolonie besteht aus einzelnen Lappen, die nur am Grunde schwach zusammenhängen—und zweitens wegen der Form der Spicula. Derartige Spiculaformen gibt es bei keiner Alcyoniumart.

Als weitere Species dubiae sind noch die alten Arten anzuführen:

A. bradleyi Verrill.
A. stellatum M. Edw., vielleicht *A. digitatum.*
A. laniciosum Esper.
A. molle (*stellatum*) Esper.

Von diesen älteren Arten kann ich infolge der mangelhaften Beschreibungen der Autoren keine Diagnose geben.

In der neuerdings erschienenen Arbeit von A. Molander (1915) wird der Versuch gemacht, *Erythropodium norvegicum* als Varietät zu *Alcyonium digitatum* zu ziehen, der indessen bereits von Kükenthal (1916) als nicht zulässig zurückgewiesen worden ist. Was die Identifizierung von *A. compressum* mit *A. glomeratum* anbetrifft, so ist nur *A. compressum* Th. Stud. (1901) synonym mit *A. glomeratum* Th. Stud. (1891), im übrigen sind es aber zwei zu trennende Arten. Die von Molander zu *Alcyonium* gestellte *Gersemia bocagei* (Kent) möchte ich bei der Gattung *Gersemia* belassen.

Zu der seinerzeit (1914) von mir gegebenen Liste zu *Alcyonium* gerechneter aber nicht dazugehöriger Arten ist folgendes hinzuzufügen:

Hartmeyer hat in seinem Aufsatz [4] eine Anzahl solcher Arten aufgeführt, und zu deuten versucht, wozu ich noch einige Bemerkungen beifügen möchte.

Alcyonium pulmonaria Ellis und Solander ist nach Hartmeyer identisch mit der Synascidie *Macroclinum pulmonaria,* aber nur möglicherweise identisch mit der von Lamouroux ebenfalls unter dem Namen *A. pulmonaria* beschriebenen Form.

Von *Alcyonium cydonium* sind 3 verschiedene Formen zu unterscheiden, von denen nach Hartmeyer *A. cydonium* Cuv. eine Synascidie ist; *A. cydonium* L. wie Linné das *A. cotonium* Pall. umtauft, ist wahrscheinlich ein Kieselschwamm; und nur *A. cydonium* Müller könnte eine Alcyoniumart darstellen, die indessen nicht identifizierbar ist.

Aus der Gattung *Alcyonium* scheiden ferner aus:

Alcyonium terminale Q. u. G. = *Lemnalia terminalis* (Q. u. G.).
Alcyonium irregulare Seba = *Janthella flabelliformis* Gray.
Alcyonium arenosum Gmel. = *Flustra arenosa* Ell. u. Sol.
Alcyonium lütkeni Verrill = *Eunephthya glomerata* Verrill.
Alcyonium constellatum Turt. ist nach Hartmeyer ein *Botryllus.*
Alcyonium agaricum Stimpson ist nach Kükenthal ein *Anthomastus,* aber nicht identisch mit *A. agaricum* Linné, das mit *Renilla reniformis* (Pall.) zu identifizieren ist.
Alcyonium asbestinum Pall. = *Briareum asbestinum* (Pall.)

[4] Verh. Ges. Naturf. Fr. Berlin (1916) No. 8.

Ferner scheiden die folgenden in meiner früheren Liste erwähnten Namen aus:

Alcyonium lobatum (Pall.) = *A. digitatum* L.

Alcyonium lobatum Burchardt ist nicht identisch mit *A. lobatum* (Pall.).

Alcyonium norvegicum Kar. u. Dan. = *Parerythropodium norvegicum* (Kar. u. Dan.) (nach Kükenthal).

Alcyonium sollasi Wright u. Stud. ist möglicherweise eine *Sinularia.*

Alcyonium haddoni Wright u. Stud. ist wohl ebenfalls zu *Sinularia* zu stellen.

Alcyonium sarcophytoides Burchardt = *Sarcophytum trocheliophorum* Marenz.

Alcyonium kükenthali Nutting = *Eunephthya spiculosa* Kükth.

Alcyonium carneum Ag. = *Eunephthya rubiformis* (Ehrbg.)

LITERATURVERZEICHNIS

BLAINVILLE. Manuel d'Actinologie (1834).

BROCH, HJ. Die Alcyonarien des Trondjemfjordes I. Alcyonacea. Norske Selsk. Skr. 1911 (1912).

COHN. Alcyonarien von Madagaskar und Ostafrica. Reise Voeltzkow **2** (1908).

DANA, J. Report on the Zoophytes of the U. S. Exploring Expedition under Capt. Wilkes, Philapelphia (1846).

EHRENBERG. Die Korallenthiere des Rothen Meeres, Berlin (1834).

ELLIS und SOLANDER. Zoophytes (1786).

GRAY, I. E. Notes on the fleshy Alcyonoid corals. Ann. & Mag. Nat. Hist. IV **3** (1869).

HASSALL, A. H. Catalogue of Irish Zoophytes. Ann. & Mag. Nat. Hist. I **6** (1841) 161–175, 3 pls.

HASSALL, A. H. Remarks on three species of marine zoophytes. Ann. & Mag. Nat. Hist. I **11** (1843) 111–113.

HICKSON, S. J. The Anatomy of Alcyonium digitatum. Quart. Journ. Micr. Sci. **37** (1895).

HICKSON, S. J. The Alcyonaria und Hydrocorallia of the Cape of Good Hope. Marine Investigations in South Africa (1900).

HICKSON, S. J. The Alcynonaria of the Cape of Good Hope, II. Marine Investigations in South Africa **3**[2] (1904).

HICKSON, S. J. The Alcyonaria, Antipatharia, and Madreporaria collected by the Huxley from the north side of the Bay of Biscaya. Journ. Marine Biol. Assoc. **8** (1907).

HICKSON, S. J. Coelenterata, I Alcyonaria. Nat. antarct. Exp. Naturw. Hist. **3** (1907).

HILES, I. L. The Stolonifera and Alcyonaria. Willey, Zool. Results pt. **4** (1900).

JOHNSTON. History British Zoophytes (1847).

KLUNZINGER, C. B. Die Korallenthiere des Rothen Meeres **1** Berlin (1877).

KOCH, G. v. Die Alcyonarien des Golfes von Neapel. Mitt. Zool. Stat. Neapel **9** (1891).

KÖLLIKER, A. Icones histologiae, 2, **1** (1866).

KÜKENTHAL, W. Diagnosen neuer japanischer Alcyonaceen. Zool. Anz. **30** (1906).

KÜKENTHAL, W. Alcyonium brioniense, ein neues Alcyonium des Mittelmeeres. Jena. Z. Naturw. 42 (1906).

KÜKENTHAL, W. Japanische Alcyonaceen. Doflein, Beitr. z. Naturg. Ostasiens. Abh. K. Bayr. Akad. Wiss. II, Kl. Suppl. 1 (1906).

KÜKENTHAL, W. Alcyonaria der Deutschen Tiefsee Exp. Erg. D. T. E. Teil 1, Heft 1, 13 (1906).

KÜKENTHAL, W. Beobachtungen an einigen Korallentieren des adriatischen Meeres. Aus der Natur (1909).

KÜKENTHAL, W. Alcyonaria I. Michaelsen u. Hartmeyer, Fauna S. W. Australiens 3 (1910).

LAMARCK. Histoire naturelle des animaux sans vertèbres (1816).

LAMOUROUX. Histoire des Polypes coralligènes flexibles vulg. nommèes Zoophytes, Caen (1816).

LINNÆUS. Systema Naturæ ed. 10 (1758).

LÜTTSCHWAGER, H. Beiträge zu einer Revision der Familie Alcyoniidae. Inaug. Diss. Breslau und Arch. Naturg. Abt. A, Heft 10 (1914).

MAY, W. Beiträge zur Systematik und Chorologie der Alcyonaceen. Jena Zeitsch. Naturw. 33 (1899).

MAY, W. Alcyonarien. Hambg. Magalh. Sammelreise (1899).

MAY, W. Alcyonarien. Fauna arctica 1 (1900).

MILNE-EDWARDS. Histoire naturelle des Coralliaires ou Polypes proprement dits. Paris 1 (1857).

NORDGAARD. Hydrogeographical and biological investigations in Norwegian Fjords (1905).

NUTTING, C. C. Descriptions of the Alcyonaria collected by the U. S. Fisheries steamer Albatross, mainly in Japanese waters, during 1906. Proc. U. S. Nat. Mus. 43 (1913).

PALLAS. Elenchus Zoophytarum (1766).

PRATT, E. M. The Alcyonaria of the Maldives pt. 2. The Fauna and Geogra. of the Maldive and Laccadive Archipelagoes pt. 1 2 (1902).

PRATT, E. M. The digestive organs of the Alcyonaria and their relation to the mesogloeal cell plexus. Quart. Journ. Micr. Sci. n. s. 49 (1905).

PRATT, E. M. On some Alcyoniidae. Pearl Oyster Fish. Rep. Manaar, Suppl. Rep. 19 (1905).

QUOY et GAIMARD. Zoologie du Voyage de l'Astrolabe sous les Ordres du Capt. Dumond d'Urville pendant les anneés 1826–29. Paris 4 (1833).

ROULE. Rés. Sci. de la campagne du Caudan (1896).

SARS, M. Bidrag til Kundsgaben om Middelhavets Littoralfauna Reisebemaerkninger fra Italien (1857).

STEPHENS. A list of Irish Coelenterata including the Ctenophora. Proc. Roy. Irish Acad. sect. B 25 (1905).

STEPHENS. Alcyonarian and Madreporarian corals of the Irish coast (1909).

STORM. Oversigt over Trondjhemfjordens fauna (1901).

STUDER, TH. Note préliminaire sur les Alcyonaires des campagnes du yacht l'Hirondelle. Mém. Soc. Zool. de France 3 (1890).

STUDER, TH. Alcyonaires provenant des campagnes de l'Hirondelle. Rés. camp. sci. acc. par. Albert 1er Prince de Monaco, fasc. 20 (1901).

TARGIONI-TOZZETTI. Nota interno ad alcune forme di Alcyonari e di Gorgonari etc. Atti Soc. Ital. 15 (1872).

THOMSON. J. A. The Alcyonaria of the Cape of Good Hope and Natal, Alcyonacea. Trans. Roy. Soc. Edinburgh pt. 3 47 (1910).

THOMSON, J. A., and HENDERSON, W. D. The marine fauna of Zanzibar and British East Africa, from collections made by Cyril Crossland, . . . 1901 and 1902. Alcyonaria. Proc. Zool. Soc. London 1 (1906) 393–443, 6 pls., 1 text fig.

THOMSON, J. A., and MACKINNON, D. L. The Stolonifera, Alcyonacea, Pseudaxonia, and Stelochotokes, in: Gardiner, I. St., Alcyonarians coll. on the Percy Slad. Trust. Exp. II, in: The Percy Slad. Trust. Exp. to the Indian Ocean, in 1905 Nr. 8 v. 2 in: Trans. Linn. Soc. London, pt. 2 13 (1910).

THOMSON, J. A., and MACKINNON, D. L. The Alcyonarians of the Thetis Expedition, Res. sci. of the Trawling Exp. of H.M.C.S. Thetis off the coast of New South Wales. Mem. Austr. Mus. Sydney 4 (1911).

THOMSON, J. A., SIMPSON F. F., HENDERSON, W. D. An account of the Alcyonarians collected by the Invest. in the Indian Ocean with a report on the species of Dendronephthya. II. The Alcyonarians of the littoral area, Calcutta (1909).

ILLUSTRATIONEN

TAFEL 1

FIG. 1. *Alcyonium pachyclados* Klzgr. Batas Island, Palawan.
2. *Alcyonium digitulatum* Klzgr. Batas Island, Palawan.
3. *Alcyonium equisetiforme* n. n. Sabong, Mindoro.

TEXTFIGUREN

FIG. 1. *Alcyonium pachyclados* Klzgr., Stielskleriten. Vergr. × 200.
2. *Alcyonium pachyclados* Klzgr., Rindenskleriten. Vergr. × 400.
3. *Alcyonium digitulatum* Klzgr. Rinden- und Stielskleriten. Vergr. × 200.
4. *Alcyonium equisetiforme* n. n., Rindenskleriten. Vergr. × 200.
5. *Alcyonium equisetiforme* n. n., Stielskleriten. Vergr. × 200.

TAFEL 1.

NEW ORIENTAL AND AUSTRALIAN ICHNEUMONIDÆ

By R. A. CUSHMAN

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ONE PLATE AND EIGHT TEXT FIGURES

This paper is based largely on specimens received from Prof. C. F. Baker, of the University of the Philippines, together with some from other sources. Most of the new species are from the Philippine Islands, though some few are from other islands, and still others from the Malay Peninsula.

So many genera have been described from the two regions involved, without synoptic keys for distinguishing them, that it is only with the greatest difficulty that species from these regions can be referred to their proper genera. I have found this especially true with the Joppinæ that I have studied. When members of described genera have been located in the material studied, I have constructed synoptic keys to all the species known from the two regions involved.

All of the text figures have been drawn by me, while the plate is from a photograph by Herbert S. Barber, of the Bureau of Entomology.

Genus **ACANTHOJOPPA** Cameron

Fifteen species of this genus have been described by Cameron, all from India and Borneo and mostly from single specimens, while, as Morley [1] has indicated, *Cryptus praepes* Bingham from the Philippine Islands also belongs here. Morley tabulated thirteen of Cameron's species, omitting *nigrinerva* and *cincticornis,* the latter described in *Anisobas* and later [2] referred by its author to the present genus. Morley suggests that *Acanthojoppa* and *Xanthojoppa* Cameron are perhaps not distinct though easily separated by the strong and complete propodeal carinæ in the former and their lack in the latter. He forthwith includes in the present genus two species, *lutea* and *curtispina,*

[1] Rev. Ichn. Brit. Mus., pt. 4 (1915) 90, footnote.
[2] Journ. St. Br. Roy. Asiat. Soc. 44 (1905) 158.

which he says lack definite areas. However this may be, there is considerable variation in the distinctness of the areolation due to depth of sculpture, and one of the species described below has some of the carinæ practically obliterated. Morley also expressed doubt of the stability of the Cameronian species. In this he may be correct, but it seems hardly possible that individuals differing so markedly as do the ones before me can represent fewer species than listed. These include ten specimens from the Philippine Islands, eight collected by C. F. Baker and two by C. R. Jones. These apparently represent six species, none of which agrees with any of Cameron's descriptions; one, however, is apparently *A. praepes* (Bingham). Not all will agree with the original description of the genus, which is to be expected since the genus was based on a single species, and many purely specific characters were mentioned in the generic description. They fall, however, into three rather distinct groups, worthy perhaps of subgeneric rank.

The following key will serve to separate the six species known from the Philippine Islands:

Key to the Philippine species of Acanthojoppa.

1. Propodeum with distinct apophyses; scutellum convex to pyramidal; pleura and propodeum sculptured; metapleurum not distinctly divided by a carina extending from middle to hind coxæ .... 2.
   Propodeum without distinct apophyses; scutellum flat or weakly convex; pleura and propodeum polished; metapleurum divided by a sharp carina extending from middle to hind coxæ .... 5.
2. Scutellum pyramidal and deeply emarginate at summit, nervulus postfurcal; malar space subequal to basal width of mandible; cheeks nearly flat; clypeus flat, not or barely separated; head not contrastingly colored .... 3.
   Scutellum convex, not emarginate at summit; nervulus interstitial; malar space much shorter than basal width of mandible; cheeks strongly convex; clypeus elevated at base and distinctly separated; head contrastingly colored with yellow and ferruginous.
   A. praepes (Bingham).
3. Flagellum largely black with a distinct white annulus .... 4.
   Flagellum testaceous at base, black at tip .... **A. mindanao sp. nov.**
4. Vertex sunken below level of top of eyes; areola strongly longitudinally rugose, open behind; apophyses distinctly behind middle of propodeum.
   A. major sp. nov.
   Vertex about level with top of eyes; areola closed behind, not strongly rugose; apophyses nearly at middle of propodeum.
   A. annulicornis sp. nov.
5. Hind tibia mostly fuscous, the tarsus yellow; areola longer than broad.
   A. polita sp. nov.
   Hind tibia and tarsus nearly uniform pale ferruginous.
   A. mutica sp. nov.

Acanthojoppa major sp. nov.

Female.—Length, 16 millimeters; antennæ, 13. Head subopaque punctate; temples convexly sloping, not nearly as wide as eyes; frons deeply concave with a slight median elevation, the antennal scrobes highly polished below; vertex medially distinctly below level of top of eyes, strongly sloping behind to occipital carina; occiput moderately concave; eyes large, bulging, divergent below, hardly longer than their distance apart below; face nearly flat, rather densely punctate, with a ridge on each side on the inner orbit, which extends obsoletely to the lateral angle of the clypeus, bordered dorsally by a curved ridge that unites at each side with the orbital ridge and extends dorsally as a fine carina nearly to top of eye; clypeus nearly flat, slightly elevated at base medially, at apex broadly rounded with a very inconspicuous median truncature, punctate at base, polished at apex; labrum subangulately rounded at apex; malar space as long as basal width of mandible; cheeks in front view nearly straight; scape distinctly elongate, flagellum rather stout, its basal joint little more than three times as long as thick at apex. Thorax densely punctate, the mesoscutum and scutellum very finely punctate, the pleura coarsely subrugulosely so; notauli obsoletely impressed to middle of mesoscutum; scutellum pyramidal, sinuately tapering toward summit, which is deeply emarginate, its sides densely punctate; propodeum rugose-punctate, basal areas polished, spiracular area open behind, apical transverse carina largely obliterated by coarse sculpture, areola nearly a regular hexagon, open behind, apophyses long and stout and situated distinctly behind middle; legs slender, hind femur reaching nearly to apex of abdomen; longer hind calcarium reaching distinctly beyond middle of basitarsus; basal vein curved; nervulus postfurcal; radius originating at middle of stigma; areolet very narrowly sessile, practically quadrilateral; first brachial cell short and much wider at apex than at base, the basal abscissæ of discoideus and brachius being strongly divergent and the second and third abscissæ of discoideus combined nearly as long as first; intercubitella little more than a third as long as basal abscissa of radiella. Abdomen minutely punctate, opaque; petiole distinctly compressed; postpetiole polished, four times as wide at apex as petiole, sides beyond spiracles divergent; second tergite wider at apex than long, gastrocœli distinct, rather broad, shallow. The area cephalad of each one longitudinally striate; third tergite nearly twice as wide at base as long; ovipositor strongly exserted.

Ferruginous; face, mandibles at base, scutella, and front and middle legs at base paler; abdomen, especially at apex, and mesoscutum slightly darker; flagellum fuscous with an incomplete whitish annulus on joints 6 to 13; legs, except apices of tarsi, testaceous; wings yellow stained; ovipositor sheath fuscous at apex.

Type locality.—Los Baños, Luzon, Philippine Islands.

Type.—Catalogue No. 24035, United States National Museum.

One female collected by C. F. Baker.

Acanthojoppa annulicornis sp. nov.

Closely related to *A. major* sp. nov. and differing from the preceding description of that species as follows:

Female.—Length, 14 millimeters; antennæ, 11. Head polished, mostly impunctate; vertex and top of eyes at about same level; vertex more rounded behind ocelli; occiput rather deeply concave; face with a slight median elevation but without the lateral ridge, sparsely punctate; clypeus hardly elevated at base but separated from face by a fine impressed line, polished throughout with scattered punctures at base, strongly rounded at apex; malar space slightly shorter than basal width of mandible; cheeks in front view distinctly convex. Thorax opaque; pronotum polished, striate along posterior margin and punctate above; mesoscutum densely, finely punctate; scutellum densely punctate above, sparsely so and polished laterally, its sides straight, parallel; mesopleurum obliquely striate-punctate; metapleurum densely punctate; propodeum transversely striate behind, polished and punctate basally; areola separated, the apical transverse carina distinct throughout; apophyses slenderer and situated very nearly at middle; areolet rather broadly sessile; brachial cell not quite so broad relatively at apex. Petiole not compressed; postpetiole three times as wide at apex as petiole, its sides only slightly divergent; second tergite narrower at apex than long, otherwise much as in *A. major;* third tergite fully two-thirds as long as wide.

Ferruginous; head in front and behind eyes, mandibles, pronotum anteriorly and ventrally yellowish, legs as in *A. major* except that hind tibia, except base, and basal two-thirds of basitarsus are fuscous; wings and abdomen as in *A. major.*

Type locality.—Mount Maquiling, Luzon, Philippine Islands.

Type.—Catalogue No. 24036, United States National Museum.

One specimen collected by C. F. Baker and one without definite locality collected by C. R. Jones and labeled "Acc. No. 771, Bur. Agr., P. I."

Acanthojoppa mindanao sp. nov.

Immediately distinguishable from the two preceding species by its smaller size and by the lack of the white antennal annulus.

Female.—Length, 12 millimeters; antennæ, 9. Differing from the preceding description of *A. major* sp. nov. as follows: Head polished, practically impunctate above and behind; vertex medially about as high as eyes, convexly sloping behind; occiput rather deeply concave; face with punctures rather dense but shallow, without orbital ridges; clypeus more sparsely punctate at base and more strongly rounded at apex; malar space distinctly shorter than basal width of mandible; cheeks in front view rather strongly convex; scape little longer than thick. Thorax and propodeum sculptured about as in *A. annulicornis* sp nov., but with metapleurum rather distinctly obliquely rugulose; notauli very weak, scutellum tapering toward summit, its lateral margins straight; areola distinctly longer than broad, closed behind, the apical transverse carina strong; apophyses slender, scarcely behind middle; areolet pentagonal, the radial side short; brachial cell with its long sides less strongly divergent, apical two abscissæ of discoideus together much shorter than first; intercubitella barely a third as long as basal abscissa of radiella. Petiole very weakly compressed; postpetiole scarcely three times as wide at apex as petiole, scarcely wider than at spiracles, its sides convex; second tergite hardly as wide at apex as long, gastrocœli not impressed, defined only by difference in sculpture, third tergite distinctly more than half as long as wide at base.

Color as in *A. major*, except that antennæ lack the white annulus, being ferruginous with the apical two-fifths fuscous, and the abdomen is uniformly darker than thorax.

Type locality.—Zamboanga, Mindanao, Philippine Islands.

Other locality.—Davao, Mindanao, Philippine Islands.

Type.—Catalogue No. 24037, United States National Museum. Two females received from C. F. Baker.

(Cryptus) Acanthojoppa praepes (Bingham).

Cryptus praepes BINGHAM, Ann. & Mag. Nat. Hist. VI **16** (1895) 443.
Microcryptus praepes ASHMEAD, Proc. U. S. Nat. Mus. **28** (1905) 155.
Acanthojoppa praepes MORLEY, Rev. Ich. Brit. Mus., pt. 4 (1915) 19, footnote.

Three specimens are at hand, two from Prof. C. F. Baker taken at Mount Maquiling, Luzon, and Butuan, Mindanao, and the third

collected by C. R. Jones and labeled "Acc. No. 752, Bur. Agr., P. I." All agree so well with Bingham's description that there can be little doubt of the correctness of the determination. Slight variations exist in the height of the scutellar carinæ and the strength of the sculpture.

This species differs from the three preceding species in having the face and pleura striate rather than punctate, the striæ on the face being arcuate and those on the pleura oblique; the clypeus strongly elevated at base and distinctly separated; the malar space much shorter than the basal width of the mandibles; the scutellum convex but not emarginate at the summit; the nervulus interstitial; and in its much smaller size. From the two following species it differs in the convex scutellum; strong propodeal apophyses; distinctly sculptured and subopaque face, pleura, and propodeum; contrastingly colored head; separated clypeus; and almost petiolate areolet.

Acanthojoppa polita sp. nov.

This and the following species differ from all those described above in having the propodeal apophyses obsolete and the pleura and propodeum polished.

Female.—Length, 14 millimeters; antennæ, 11. Head polished throughout except that face is medially arcuately striate above; clypeus polished, strongly elevated at base, the elevation continuous with the median elevation of the face, foveæ very deep, apex broadly rounded, medially subtruncate; labrum exserted; malar space much shorter than basal width of mandible; cheeks in front view straight; vertex impressed below top of eyes, sharply declivous behind; occiput rather deeply concave; eyes large and prominent. Mesoscutum and scutellum opaque; thorax otherwise polished, practically without sculpture, although the propodeum is obsoletely transversely rugulose; notauli sharply defined to middle of mesoscutum; scutellum flat above, the carinæ becoming gradually weaker toward apex, which is subtruncate; lower portion of metapleurum separated off by a sharp arcuate carina between middle and hind coxæ (in the four preceding species this carina is visible only anteriorly); median areas of propodeum narrow, the areola much longer than wide, long horseshoe-shaped and far removed from base of propodeum, lateral abscissæ of apical carina far behind middle abscissa; areolet rather broadly sessile; nervulus antefurcal; first brachial cell nearly parallel-sided and about twice as long as wide. Abdomen opaque, narrow; first tergite stout, polished, petiole nearly

half as wide as postpetiole; second tergite nearly twice as long as wide at base; third and fourth nearly quadrate; ovipositor very briefly exserted; epipleura of middle tergites broad.

Dark ferruginous; face and clypeus yellowish; antennæ black, ferruginous at base and with an incomplete white annulus embracing flagellar joints 8 to 14; wings yellowish hyaline, venation ferruginous; hind tibia except at base black; hind tarsus white, its basal joint fuscous at extreme base, apical joint ferruginous.

Type locality.—Los Baños, Luzon, Philippine Islands.

Type.—Catalogue No. 24038, United States National Museum. One female received from C. F. Baker.

Acanthojoppa mutica sp. nov.

Male.—Length, 9 millimeters; antennæ, 9. Agrees with *A. polita* sp. nov. in lacking the propodeal apophyses, the low scutellum, and the polished pleura and propodeum, but differs as follows: Face medially punctate, raised laterally above the outer corners of the clypeus; clypeus nearly flat with deep foveæ, apex truncate and with a single row of large punctures; labrum concealed. Thorax about as in *A. polita,* but scutellum distinctly convex and notauli much shorter; median areas of propodeum broader, areola nearly as broad as long, hexagonal, and very close to base of propodeum, lateral abscissæ of apical carina practically continuous with median abscissa; nervulus interstitial. Abdomen broader, second and third tergites punctate at least basally, all beyond second broader than long.

Pale ferruginous, thorax laterally, petiole, and front and middle legs luteous; antennæ black, ferruginous at base and pale in middle; wings only slightly yellow tinged; hind legs ferruginous, the tarsi only slightly paler.

Type locality.—Zamboanga, Mindanao, Philippine Islands.

Type.—Catalogue No. 24039, United States National Museum. One male received from C. F. Baker.

Genus **CTENOCHARIDEA** novum

The pectinate claws place this genus in the Listrodromini. In Ashmead's key to that tribe it runs to *Ctenochares* Foerster. No specimen of that genus is available for comparison, but from the description of it and its various synonyms the present genus differs in having the head rather broad behind the eyes, the clypeus rounded at apex, the thorax short and stout, the propodeum without teeth, the wings not clouded at apex, and the areolet obliquely trapezoidal.

Female.—Head transverse, nearly as broad behind eyes as at eyes; temples convex; occiput deeply concave, completely margined; vertex long, the ocelli placed well forward of a line drawn tangent to posterior margins of eyes; frons concave; cheeks broad, weakly buccate but widely visible in front view of head; malar space broad, though much narrower than mandibles; eyes large, strongly convex; face slightly elevated in middle and at sides below; clypeus large, broad, separated from face only weakly by elevation, broadly arcuate at apex, foveæ small; labrum scarcely exserted; mandibles large, strongly curved, bidentate at apex, the teeth large, the upper somewhat the longer; maxillary palpi very long, reaching well beyond apex of front coxæ, second joint triangular; antennæ much shorter than body, slightly incrassate and flattened beneath beyond middle; thorax short and stout; dorsolateral margins of pronotum callose, epomia strong; notauli indicated by the elevation of the prescutum; scutellum large, about as broad at base as long, sides subparallel, rounded at apex, margined to apex, flattened above, elevated and precipitous at apex, separated from mesoscutum by a very deep and narrow furrow; postscutellum and its lateral foveæ foveolate; prepectal carina strong to near top of mesopleura, with a deep angulation at the sternaulus, the latter broadly and weakly impressed; mesopleural furrow foveolate; subalar tubercle with a high, flangelike carina; propodeum rounded above, declivous behind, without spines, areolated only in basal half, areola large, rounded in front, open behind, extending very nearly to base, spiracular area open behind, the spiracles long slitlike; pleural carina complete; legs rather long, slender, the calcaria long, claws pectinate; wings rather short, second abscissa of radius curved at base, areolet oblique trapezoidal, discocubitus weakly curved, with ramellus represented by a slight angulation; nervulus strongly postfurcal; nervellus reclivous, broken near base; abdomen long, narrow, acute at apex, with seven visible tergites, the last as long as sixth; first tergite curved, petiole slightly wider than thick, postpetiole very broad, depressed, spiracles large, elongate; second tergite with large, shallow, subtriangular gastrocœli at outer anterior corners, partially hidden by second tergite; ovipositor exserted.

Type, *Ctenocharidea luzonensis* sp. nov.

Ctenocharidea luzonensis sp. nov.

Female.—Length, 15 millimeters; antennæ, 10; front wing, 10. Head mostly polished impunctate; face and malar space

closely, finely punctate; malar space half as long as basal width of mandible; clypeus obscurely punctate at base, polished at apex; pronotum polished, lower angle obscurely rugulose; mesoscutum and scutellum opaque, reticulate punctate, prescutum anteriorly only weakly sculptured; mesopleurum and metapleurum densely punctate, former with a polished impression in middle; prepectus more finely punctate; basal lateral areas polished, areola coriaceous, propodeum otherwise coarsely rugose-punctate especially in posterior middle; petiole polished, postpetiole coriaceous with a narrow line of large punctures on each side of middle; second and third tergites and fourth except at apex densely, opaquely punctate; apex of fourth and apical tergites polished.

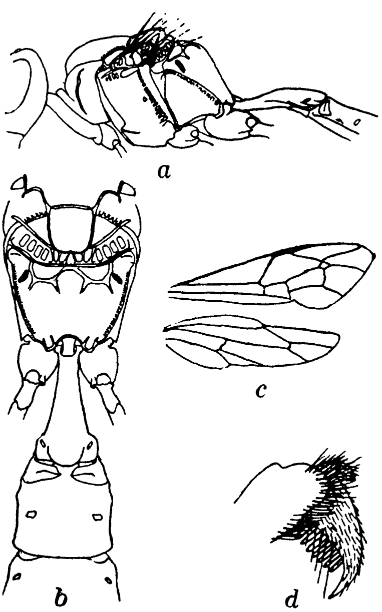

FIG. 1. *Ctenocharidea luzonensis* sp. nov.; *a*, thorax and base of abdomen, lateral view; *b*, portion of thorax, propodeum, and base of abdomen, dorsal view; *c*, wings; *d*, claw of hind tarsus.

Black with yellow markings as follows: Face, except a small median spot, clypeus, mandibles, orbits except an interruption at top of eyes, anterior margin of pronotum except a narrow interruption on each side, dorsolateral margin of pronotum, propleura below, two spots in middle of mesoscutum, apex of scutellum, base of tegulæ, lower half and upper front angle of mesopleurum and a line at its posterior margin, most of metapleurum, a spot on each side of propodeum, base of petiole, apical margins of all tergites, and gastrocœli. Antennæ black with more or less of the upper side of flagellar joints 8 to 19 white; palpi pale; front and middle coxæ and trochanters yellowish, their femora and tibiæ testaceous, more or less fuscous above, and their tarsi fuscous; hind coxæ black without, yellow within, basal joint of trochanter black, apical joint yellow, femur piceous at base and at extreme apex, otherwise testaceous, tibia and tarsus fuscous, calcaria yellow. Wings dilute brownish.

Type locality.—Mount Maquiling, Luzon, Philippine Islands.

Type.—Catalogue No. 24040, United States National Museum. One female from C. F. Baker.

Genus PYCNOPYGE novum

In Berthoumieu's key to the Joppini [3] this runs fairly satisfactorily to the Neotropical genus *Conopyge* Kriechbaumer and, although markedly different in general appearance from that genus, apparently has more in common with *Conopyge* than with any of the Oriental joppine genera described by Cameron and Kriechbaumer. It especially resembles *Conopyge* in the thick head with the rather weakly concave occiput, the propodeal areolation, the broad, medially elevated postpetiole and the suddenly smaller, compressed, and weakly sculptured apical tergites. The medially produced clypeus, distinct notauli and sternauli, less-strongly elevated scutellum, nearly quadrangular areolet, larger fourth tergite, and highly ornamented body form the best characters for distinguishing it from *Conopyge*.

Female.—Head about half as thick anteroposteriorly as broad; occiput rather weakly concave, margined; temples broadly rounded; eyes large, ovate, parallel and entire within; frons shallowly concave, broadly margined laterally and above; face slightly elevated in the middle, flat at sides; clypeus indistinctly separated by elevation from face, flat, nearly as long as broad, roundly prolonged medially at apex, foveæ small; labrum concealed; malar space broad; cheeks convex; antennæ distinctly shorter than body, incrassate beyond middle and rather nearer to the apex than usual, the incrassate portion flattened below and depressed rather than compressed; second joint of maxillary palpi triangular; upper tooth of mandible the larger; thorax ovoid; pronotum with a short strong carina just in front of the humeral angle, the carina terminating above in a distinct angulation; epomia present; notauli and sternauli distinct; prepectal carina strong and complete, reaching nearly to dorsal margin of mesopleura; scutellum convex, margined laterally and apically; propodeum with dorsal face short, posterior face sharply declivous, concave, median longitudinal carinæ behind areola and lateral longitudinal carinæ before the apical carina lacking, areola broad, apical carina at its intersections with the lateral longitudinal carinæ forming on each side a blunt tooth, pleural carina complete, though somewhat obscured by coarse sculpture, spiracle small, elongate oval; wings immaculate; areolet nearly rhomboidal; legs short, stout, hind femur reaching to apex of second tergite; longer calcarium of hind tibia reaching beyond middle of metatarsus; abdomen lan-

[3] Gen. In. fasc. 18 (1904).

ceolate, with seven visible tergites; first tergite nearly as broad at apex as long, petiole rather slender, postpetiole abruptly wider and elevated medially, spiracles well removed from margin, round; this tergite in profile with ventral margin nearly straight, the dorsal margin ascending in a straight line to the summit of the elevation, thence at nearly a right angle to the apex; second tergite coarsely striate-punctate, gastrocœli near base, deep, transverse, separated medially by about half their length; third tergite strongly constricted at base, sculptured like the second; fourth tergite very weakly striate-punctate, tergites 5 to 7 suddenly smaller, polished, compressed, the seventh barely visible; ovipositor exserted, the sheath compressed; black, highly ornamented with yellow; antennæ white annulate.

Male.—Unknown.

Type, *Pycnopyge bella* sp. nov.

Pycnopyge bella sp. nov.

Female.—Length, 9 millimeters; antennæ, 6. Head polished; face sparsely, coarsely punctate; pronotum polished, with a broad foveolate groove along lower posterior margin; mesoscutum opaque, with large, irregularly spaced punctures anteriorly, the notauli foveolate, narrow for half their length, then suddenly broadening with the foveolæ large and transverse; scutellum coarsely pitted dorsally and polished and more or less striate at sides; postscutellum coarsely longitudinally striate, the lateral foveæ strongly foveolate; mesopleurum coarsely, densely punctate, broadly foveolate along posterior margin, a short foveolate groove below the subalar tubercle, a broad ridge outside the sternaulus subtending a foveolate groove; mesosternum densely punctate; metapleurum densely coarsely punctate, divided longitudinally by a strong carina, above which is a foveolate groove; propodeum with basal areas subpolished, areola transverse; rounded in front with a median longitudinal carina anteriorly and several carinæ posteriorly, middle of posterior face coarsely transversely striate, propodeum otherwise densely reticulately punctate.

Black; face, clypeus except apex and dorsal margin, orbits, interrupted narrowly at top of eye and broadening below to include entire cheeks, spots on pronotum dorsally and on ventral angle, on disk of mesoscutum, scutellum, postscutellum, upper anterior angle of mesopleurum and one in front of middle coxa, upper part of metapleurum, each side of propodeum behind, first tergite except postpetiole medially, posterior angles of second and third tergites and second basally at sides, and

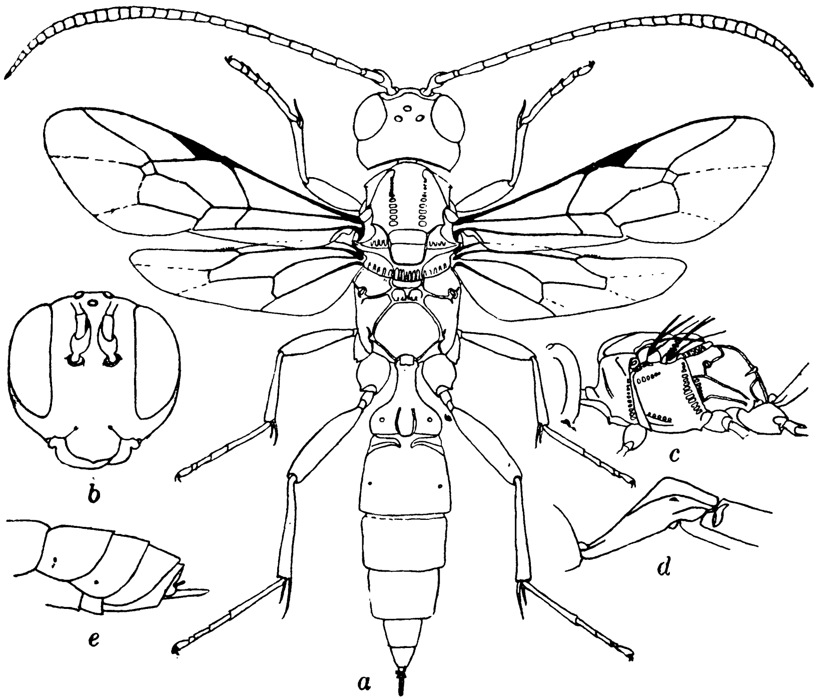

FIG. 2. *Pycnopyge bella* sp. nov., female; *a*, entire insect; *b*, head, front view; *c*, thorax, lateral view; *d*, first abdominal segment, lateral view; *e*, apex of abdomen, lateral view.

apical margins of sixth and seventh tergites yellow; mandibles piceous, slightly yellow near base; antennæ brown at base, paler below; black at apex, the white annulus occupying flagellar joints 8 to 17 incomplete below; palpi, front and middle coxæ and trochanters, and a dorsal spot on hind coxa stramineous; hind coxæ and trochanters reddish piceous; all femora and front and middle tibiæ testaceous; hind tibia above and all tarsi fuscous; wings hyaline, venation fuscous, stigma paler in middle.

Type locality.—Mount Maquiling, Luzon, Philippine Islands.

Type.—Catalogue No. 24041, United States National Museum. A single specimen from C. F. Baker.

Genus NESOSTENODONTUS novum

The acute and edentate mandibles place this genus in the Heresiarchini. In Ashmead's key [4] to that tribe it runs best, because of the missing basal median area and spines of the propodeum and the immargined scutellum, to *Stenodontus* Ber-

[4] Proc. U. S. Nat. Mus. 23 (1900) 20.

thoumieu; and, in spite of the very conspicuous differences, is apparently more closely related to that genus than to any of the other genera included by Ashmead or to any of Cameron's Oriental heresiarchine genera. In the apically rounded clypeus, the distinct sternauli, the straight first tergite, the exserted ovipositor, and the wing venation it is further allied to *Stenodontus*. The posteriorly and dorsally swollen head with very deeply concave occiput; the strongly dentate clypeus; the less-strongly convex face; the longer-jointed, compressed flagellum; the lack of areolation on the posterior half of the propodeum; the longer, slenderer legs; the very inconspicuous, basally located gastrocœli; and the highly ornamented body readily distinguish it from that genus.

Female.—Head as broad behind eyes as at eyes, the temples convexly sloping, nearly as long anteroposteriorly as eye; occiput almost semicircularly excavated, strongly and completely margined; vertex strongly elevated above eye margins, declivous both before and behind, the upper margins of eyes and of posterior ocelli at the same level; cheeks rather weakly convex and, compared with the temples, narrow; frons not at all excavated; face weakly convex; eyes broadly reniform, parallel within; clypeus distinctly separated from face, medially by elevation and laterally by deep oval foveæ, broadly arched basally and rounded apically, the apex margined with a row of conspicous, uneven teeth; labrum not exserted; mandibles strongly curved, very acute; malar space practically obliterated; second joint of maxillary palpus triangular; antennæ about three-fourths as long as body, incrassate and somewhat compressed beyond middle; scape robust, deeply emarginate, basal joints of flagellum slender. Thorax scarcely as wide as head; pronotum with upper margin swollen laterally, epomia absent; notauli obsolete, being represented anteriorly on each side by a small pit; scutellum large, flat, not at all elevated above level of mesoscutum; prepectus strong and complete; sternauli distinct for about half the length of the mesopleura; a broad, low, polished elevation below the wings; propodeum weakly and narrowly set off from postscutellum, gently curved from base to apex, with a broad shallow longitudinal groove from apex of areola to apex, only basal lateral areas and areola defined, the basal median area represented by a single short median carina, spiracles small, about twice as wide as long; wings immaculate, areola trapezoidal, suboblique; legs long, rather slender, hind metatarsus comprising about half of the tarsus, hind coxæ with neither spine nor scopa beneath.

Abdomen with seven visible dorsal segments, narrowly lanceolate, widest behind middle, acute at apex; first segment slightly longer than second, widening rather abruptly at the round spiracles, which are at the apical fourth, in lateral view perfectly straight with the postpetiole but little higher than petiole, suture between tergite and sternite entirely absent or else the sternite is entirely concealed by the tergite; gastrocœli at extreme base of second tergite; lunulæ distinct on second and third tergites, circular; seventh tergite about as long as penultimate; hypopygidium far from apex of abdomen; ovipositor briefly exserted.

Male.—Unknown.

Type, *Nesostenodontus bakeri* sp. nov.

Nesostenodontus bakeri sp. nov.

Female.—Length, 10 millimeters; antennæ, 7.5. Face punctate, coarsely and rugosely so medially, more finely and sparsely so laterally; clypeus polished, with small, scattered punctures; frons and vertex immediately around ocellar triangle coarsely, irregularly punctate; head otherwise polished, impunctate; pronotum polished, weakly punctate anteriorly and crenulate along posterior margin; propleura densely, finely punctate; mesoscutum densely and finely punctate anteriorly, coarsely and sparsely so medially, polished impunctate laterally; scutellum polished, with a few large, very shallow punctures; lateral foveæ of postscutellum foveolate; mesopleura, except rounded elevation under wings, and prepectus densely, coarsely punctate, the former crenulate along posterior margin; propodeum opaque, basal areas sparsely and coarsely punctate; areola coriaceous; median groove coarsely, transversely punctate, almost crenulate; propodeum otherwise coriaceous with more or less distinct punctuation; coxæ, especially hind pair, densely punctate; first tergite polished, postpetiole obscurely punctate; second tergite finely, densely, longitudinally punctate; third to sixth progressively less distinctly punctate; seventh polished, impunctate; ovipositor exserted nearly the length of the seventh tergite.

Black; mandibles, clypeus, inner and posterior orbits, large spots at top of eye, on dorsolateral and anteroventral margins of pronotum, subalar region of mesopleurum, scutellum, metapleurum, and on each side of propodeum posteriorly yellow; apical margin of clypeus and scape testaceous; flagellum brown at base, black at apex, with joints 8 to 20 largely white, a narrow ventral line black; palpi and front and middle legs to near apex of femur white, legs beyond this point testaceous with last tarsal joint

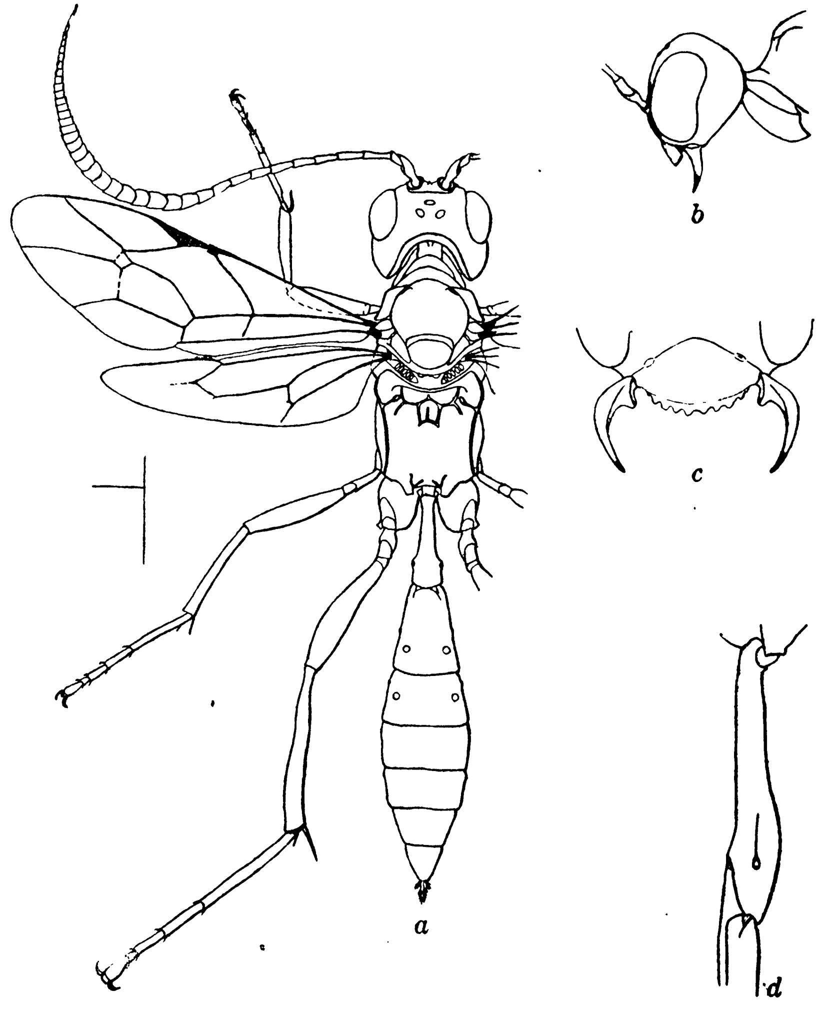

FIG. 3. *Nesostenodontus bakeri* sp. nov., female; *a*, dorsal view; *b*, head, lateral view; *c*, clypeus and mandibles; *d*, first tergite, lateral view.

fuscous; hind coxa and trochanter black to piceous, coxa and the basal joint of trochanter each with a large white spot dorsally, femur testaceous, tibia and base of metatarsus rufofuscous, apical tarsal joint black, tarsus otherwise white; abdomen black; petiole pale testaceous at base, white at apex; tergites 2 to 5 white at apex, narrowly in middle, broadly at hind angles; tergites 6 and 7 dorsally largely white.

Type locality.—Mount Maquiling, Luzon, Philippine Islands.

Type.—Catalogue No. 24042, United States National Museum.

Described from one female received from C. F. Baker.

Genus **IDIOGNATHUS** novum

I am at a loss to know whether to refer this genus to the Joppini or to the Amblytelini. None of the keys for the separation of the tribes of the Joppinæ furnishes characters that can be interpreted positively for distinguishing these two tribes. In general form it resembles much more closely the Heresiarchini, especially the genus *Nesostenodontus,* described above, but the strongly bidentate mandibles exclude it from that tribe. In almost every other part it is extremely similar to *Nesostenodontus,* especially in the clypeus, the shape of the head, the scutellum, the propodeum, and the venation of the wings. So striking is this similarity that I cannot believe that the form of the mandibles is of real tribal significance in this subfamily. The same may be said of the characters employed for the separation of the Joppini and Amblytelini. In none of the keys to either of the two tribes does it run to anything that is at all related to it; in fact one is constantly in doubt, especially with Berthoumieu's keys,[5] which alternative to follow.

Head very similar in shape to that of *Nesostenodontus* gen. nov. but shorter and slightly narrower behind the eyes than at the eyes; occiput deeply but not nearly semicircularly excavated, completely margined; face medially roundly elevated; clypeus large, arched at base, separated from face, rounded at apex and without apical serrations; eyes broadly reniform; malar space nearly obliterated; mandibles strongly bidentate, dorsal tooth somewhat the longer; second joint of maxillary palpus triangular; antennæ nearly as long as body, in female weakly incrassate beyond middle, the incrassate portion flattened below, but barely perceptibly compressed, in male filiform, not serrate. Thorax scarcely as broad as head; pronotum slightly swollen at humeral angles, epomia distinct; notauli sharply defined for about a third the length of the mesoscutum; scutellum large, nearly flat in female, slightly convex in male; subalar elevation on mesopleurum weak; sternauli short, broad but distinct; lateral foveæ of postscutellum not crenulate; propodeum obtusely dentate posteriorly; basal median area confluent with lateral areas, which are in turn partially confluent with the spiracular areas, none of the longitudinal carinæ reaching the base of the propodeum; areola broadly hexagonal, nearly round anteriorly; apical carina strong; median longitudinal carinæ obsolete or wanting behind areola; spiracles small oval; wings immaculate; areolet

[5] Gen. Ins. fasc. 18 (1904).

practically quadrangular; slightly oblique; legs long, slender, hind metatarsus nearly as long as remaining joints combined. Abdomen in female barely longer than head and thorax combined, narrow, obtuse, with seven tergites visible; in male distinctly longer and with eighth tergite visible; first tergite slightly shorter than second, slightly broader than thick at base and flattened dorsally, gradually broadening from base to spiracles, nearly half as broad at apex as long, in lateral view straight, the dorsal line a gentle curve from base to apex, with a strong carina from dorsal margin of spiracle to base and another from ventral margin of spiracle to apex, spiracles small oval, at apical fifth; second tergite with gastrocœli large, shallow, transverse, distant from base by about their length and from each other by less than their length; lunulæ on second and third tergites small, round; third tergite with large, shallow, transverse gastrocœli at extreme base partially covered by second tergite; hypopygidium retracted; ovipositor exserted.

Type, *Idiognathus balteatus* sp. nov.

Idiognathus balteatus sp. nov.

Female.—Length, 10 millimeters; antennæ, 9. Face finely, sparsely punctate, more densely so in middle, frons below and laterad of ocelli finely, irregularly arcuately striate; head otherwise polished; pronotum polished, slightly roughened on ventral angles; mesoscutum opaque, finely and sparsely punctate; scutellum polished; mesopleurum punctate below, polished above, the sternum punctate; metapleurum punctate; propodeum subopaque coriaceous, polished medially behind; abdomen opaque; second tergite longitudinally striate in its basal two-thirds, second obscurely so in basal middle; apical tergites subpolished.

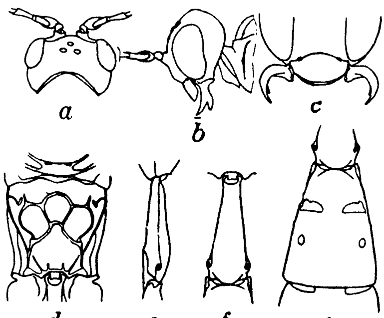

FIG. 4. *Idiognathus balteatus* sp. nov.; *a*, head, dorsal view; *b*, head, lateral view; *c*, clypeus and mandibles; *d*, propodeum; *e*, first abdominal segment, lateral view; *f*, first abdominal segment, dorsal view; *g*, second tergite, dorsal view.

Head black; mandibles, clypeus, and large spot on lower, inner orbits and at top of eyes yellowish white; palpi white; antennæ testaceous at extreme base, black at apex, with a ventrally incomplete white annulus occupying nine to ten joints beyond the sixth flagellar joint; thorax black to piceous dor-

sally, rufous ventrally and laterally except on prothorax; humeral and subalar spots, scutellum, and apex of propodeum yellow; legs pale testaceous; front coxæ and trochanters white; hind tibiæ slightly infuscate, calcaria darker, their tarsi white with apical joint and extreme base of first joint fuscous; wings brownish hyaline, venation fuscous, stigma slightly paler, radix white, tegula brown; abdomen black to piceous, a broad band at apex of second tergite and a large anal spot comprising part of the sixth and seventh tergites yellowish white; other tergites inconspicuously paler at apices; gastrocœli rufous.

Male.—Length, 9 millimeters; antennæ, 9. Aside from the sexual differences mentioned in the generic description, the male differs from the female practically only in having the antennal annulus two joints farther out and the anal spot including only the apical middle of the sixth tergite.

Type locality.—Los Baños, Philippine Islands.

Other locality.—Mount Maquiling, Luzon, Philippine Islands.

Type.—Catalogue No. 24043, United States National Museum.

Described from two females and two males received from C. F. Baker, the females from the type locality and the males from Mount Maquiling. The paratypes differ in no essential particular from the type and allotype.

Genus **ELASMOGNATHIAS** Ashmead

The receipt from Prof. C. F. Baker of seven specimens of this genus representing four species furnishes opportunity for further discussion of the genus.

Ashmead was in error in regard to the number of palpal joints. Both the labial and maxillary palpi are normal in this respect, the former being four-jointed and the latter five-jointed. Ashmead also erred in the proportions of the scape, which in his type specimen is not more than two and a half times as long as thick. The notauli are very briefly and shallowly indicated anteriorly. The areola may be longer than wide, as in Ashmead's type, or wider than long, this variation occurring within a species. The nervellus is typically amblyteline, like half of a brace above and straight below the fracture. The mandibles are curiously twisted in such manner as to bring both teeth into the same plane as the face and clypeus.

In addition to the characters mentioned by Ashmead, the following are worthy of note: Head polished, entirely or practically impunctate except face, which is finely, weakly so; malar space long; cheeks, temples, and vertex buccate; ocelli placed

well in front of posterior margins of eyes; occiput margined; face flat above with a curved ridge connecting the antennal foramina; clypeus slightly concave; antennæ nearly as long as body, slightly thickened beyond middle and very attenuate toward apex, the annulus beginning on flagellar joint 6 and including more or less of nine to eleven joints, interrupted below on all but a few joints; thorax and propodeum opaque, the sculpture rather fine; epomia strong; prepectus complete, extending dorsally about half the posterior length of the pronotum; propodeum completely areolated basally and with the petiolar area distinct, but the carinæ defining the middle and posterior lateral and pleural areas obsolete or lacking; wings reaching nearly or quite to apex of abdomen; legs, especially posterior, long, hind femur reaching nearly to apex of abdomen; longer calcarium of hind tibia reaching nearly or quite to middle of basitarsus; abdomen about as long as head and thorax, scarcely as broad as thorax, polished except second tergite and base of third; first tergite distinctly bent, postpetiole distinctly separated; spiracles rather prominent, oval.

Caenojoppa Cameron from the description is very similar in many respects and may have to supersede Ashmead's name. Except that in *Elasmognathias* the propodeum is scarcely impressed medially at base and that the abdomen has the eighth tergite visible, I would be inclined to synonymize the two genera.

Key to the species of Elasmognathias.

1. Propodeum with apophyses obsolete; thorax and propodeum strongly sculptured, the sculpture mostly punctuation; postscutellum longitudinally rugose; prepectus not subemarginate at sternauli, latter weak .... 2.
   Propodeum with apophyses strong; thorax and propodeum weakly sculptured, the sculpture mostly fine striation; postscutellum not rugose; prepectus subemarginate at sternauli; latter sharply impressed. **E. dentatus sp. nov.**
2. Spiracular area and metapleurum each with a large yellow spot; scutellar carinæ not especially high .... 3.
   Spiracular area and metapleurum entirely black; scutellar carinæ very high and laminate basally .... **E. laminatus sp. nov.**
3. Hind tarsi black at base, the calcaria reddish; scutellum evenly convex. **E. cephalotes (Ashmead).**
   Hind tarsi entirely white, the calcaria black; scutellum distinctly elevated. **E. albitarsis sp. nov.**

Elasmognathias albitarsis sp. nov.

Female.—Length, 12 millimeters; antennæ, 12; front wing, 8. Very closely allied to *E. cephalotes* (Ashmead), differing

practically only as follows: Scutellum distinctly elevated, the highest point before the middle; posterior portion of propodeum with lateral and transverse carinæ practically wanting (in *E. cephalotes* these carinæ are distinct, though weaker than the others); facial black spot shaped like a spade of a playing card, with point down and not reaching clypeus (in *E. cephalotes* this spot is oblong and in the type runs laterally along the clypeal margin; in both species the spot is connected by a narrow line between the antennæ with the frontal black area); outer apical corner of tegulæ black; black of first tergite extending more than halfway to base; hind trochanters largely yellow, femur broadly black at base and apex, with a yellow spot on the outside at apex, tibia largely black with a basal yellowish spot at base confluent with the apical spot of femur and a poorly defined yellowish annulus before the middle but with no dorsal apical spot, tarsus entirely whitish, calcaria black; wings with a distinct brownish stain.

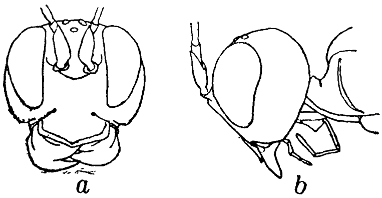

FIG. 5. *Elasmognathias albitarsis* sp. nov., head; *a*, ventrocephalic view; *b*, lateral view.

Type locality.—Mount Banahao, Luzon, Philippine Islands.

Type.—Catalogue No. 24044, United States National Museum. One specimen from C. F. Baker.

Elasmognathias laminatus sp. nov.

Distinct from any known species by the very high, laminate scutellar margins and the arrangement of the color pattern.

Female.—Length, 8 millimeters; antennæ, 8; front wing, 6.5. In structure and sculpture generally very similar to *E. cephalotes* and *E. albitarsis* but with scutellum more rugose and sloping from before the middle, very high and laminate. Color as in *E. cephalotes* except as follows: Facial black spot not connected with frontal; supraorbital spot confluent with postorbital; no mesoscutal spots; postscutellum entirely black; spiracular and metapleural spots lacking; first tergite largely black; yellow of other tergites confined largely to apical angles, except on seventh, which has a large median spot; hind coxæ black with a large yellow spot above; hind femur and tibia without yellow apical marks; hind tarsus and calcaria entirely fuscous.

Type locality.—Iligan, Mindanao, Philippine Islands.

Other locality.—Butuan, Mindanao, Philippine Islands.

Type.—Catalogue No. 24045, United States National Museum. Three females from C. F. Baker.

Elasmognathias dentatus sp. nov.

Distinct from all known species by the strong propodeal spines, striate sculpture of the thorax, and arrangement of color.

Female.—Length, 10 millimeters; antennæ (broken); front wing, 8.5. Face very weakly punctured; thorax and propodeum mostly finely striate; mesoscutum weakly punctate; scutellum elevated, at summit with a more or less distinct median elevation, postscutellum smooth; carinæ weak; prepectus subemarginate at sternauli, latter sharply impressed; propodeum with a strong blunt tooth on each side surmounted by a carina, other carinæ in this region wanting. No black mark on face; eyes entirely surrounded by yellow; thorax black, with broad anterior margin and humeral margin of pronotum, tegulæ, scutellum and postscutellum, lower half and posterior margin of mesopleurum, subalar tubercle, dorsoanterior division of metapleurum (that portion of metapleurum lying between the mesothorax and propodeum), large spot at apex of metapleurum, one on each side of propodeum surrounding and including the spines yellow; front and middle coxæ and trochanters and basal joint of hind trochanter, hind coxa except a large black spot nearly encircling the coxa yellow; front and middle tarsi fuscous; hind tarsi white, narrowly black at base; legs otherwise stramineous to testaceous, the hind femur and tibia more or less piceous at base and apex; calcaria fuscous; wings yellowish hyaline. Abdomen black with petiole, apex of postpetiole, and apices of all other tergites, more broadly at sides, yellow.

Type locality.—Los Baños, Luzon, Philippine Islands.

Other locality.—Mount Maquiling, Luzon, Philippine Islands.

Type.—Catalogue No. 24046, United States National Museum. Two females from C. F. Baker.

The paratype is somewhat more heavily sculptured than the type, especially on the mesoscutum, and has the apical elevation of the scutellum less prominent.

CRYPTINÆ

The two Oriental genera treated below run in Schmiedeknecht's Genera Insectorum key to the Mesostenini directly to *Nematopodius* Gravenhorst, and are rather closely related to that genus. The following key will serve to separate the three genera:

Key to the genera of the subfamily Cryptinæ.

1. Antennæ distinctly shorter than body, somewhat thickened toward apex; areolet defined, though often open; nervellus broken below middle; propodeum without any trace of apical carina, spiracles very small, nearly round .... Nematopodius Gravenhorst.
   Antennæ nearly or quite as long as body, very slender, filiform or attenuate toward apex; areolet not defined; nervellus broken above middle; apical carina developed at sides; spiracles large, long oval.... 2.
2. Malar space and clypeus very short, latter extending far laterally below eyes; epomia ending above in a sharp tooth; thorax and propodeum polished, impunctate; prescutum gibbous.................. Earrana Cameron.
   Malar space and clypeus not especially short, latter not especially produced laterally; epomia becoming obsolete above; thorax and propodeum very coarsely punctate; prescutum very low anteriorly. Esuchonematopodius g. nov.

Genus EARRANA Cameron

Earrana CAMERON, Spolia Zeylanica 3[10] (1905) 119, pl. B., fig. 3.
Parca MORLEY, Rev. Ich. in Brit. Mus., pt. 2 (1913) 133; Fauna Brit. India, Hym. 3, Ichn., pt. 1 (1913) 301, fig. 102.

I think there can be no doubt of the synonymy of Morley's genus. His type is from the identical locality with Cameron's, and so far as the two generic descriptions treat of the same structures they coincide very closely. There also seems to be very little if any reason to doubt the synonymy of the two genotypes. In Morley's placing of the genus it is without doubt "a remarkably distinct genus" and "by no means a typical Paniscid."

The following generic description includes characters not mentioned by either Cameron or Morley and introduces the hitherto unknown male: Entire body polished, practically without sculpture; head distinctly wider than thorax, transverse, with temples convexly sloping; eyes large, prominent, their inner margins entire, convergent below; clypeus distinctly separated, very broad and extending laterally far under eyes, foveæ touching eyes; mandibles very narrow at apex, the lower tooth obsolete to absent; occiput rather deeply concave, the carina lacking medially; antennæ nearly as long as body, very slender, filiform; maxillary palpi long, all joints slender, slightly deeper than high; pronotum with a strong curved carina along its anterolateral margin, epomia strong, straight, ending above in a sharp tubercle; propleura longitudinally carinate outwardly; notauli deep and complete, meeting before the scutellum, prescutum and lateral lobes strongly convex; scutellum nearly convex, margined at base; sternauli nearly complete, weakly double-

curved; prepectus reaching about halfway up mesopleurum; propodeum extending far beyond base of hind coxæ; basal carina of propodeum strong, apical carina developed laterally; spiracle rather large, long oval; wings long, narrow; stigma very narrow, lanceolate, radius far before middle; second intercubitus entirely lacking, first much reduced, recurrent nearly interstitial; nervulus antefurcal; nervellus strongly reclivous, broken distinctly above middle, upper abscissa perpendicular to cubitella; legs very slender; front basitarsus longer than combined remaining joints; abdomen much narrower than thorax, its basal three segments combined as long as head and thorax combined; first tergite very narrow, with an acute projection on each side at base, spiracles just before middle, prominent; second tergite subequal in length to first, but little wider at apex than at base, constricted near base, with an oblique furrow on each side before the constriction, spiracles slightly before middle, remaining tergites little longer than first two combined; ovipositor sheath about as long as first tergite; valves of the sheath in male long and slender, much as in *Mesochorus,* slightly clavate at their apices.

Earrana dimidiatus (Brullé).

Ischnoceros dimidiatus BRULLÉ, Hist. Nat. Ins. Hym. 4 (1843) 262, pl. 42, fig. 1.

I think there can be no doubt of the propriety of referring this species to *Earrana.*

Earrana malayensis sp. nov.

Female.—Length, 10 millimeters; antennæ, 9; ovipositor, 1.7; front wing, 7. Face below little more than half as broad as vertex; clypeus slightly more than twice as wide as long, apex sinuate medially; malar space about half as long as basal width of mandible; ocellocular line fully as long as width of ocellar triangle; upper end of epomia only slightly more prominent than the rest; depression behind epomia and lower posterior margin of pronotum, lateral depressions of postscutellum, and mesopleural furrow foveolate; first tergite about twice as wide at apex as at narrowest point; second distinctly more than twice as long as wide at apex, its sides parallel beyond spiracles; third two-thirds as long as second; others of rapidly decreasing length; ovipositor sheath slightly longer than first tergite.

Ferruginous; vertex and frons more or less piceous; inner orbits from top of eye, entire face and clypeus, and mandibles

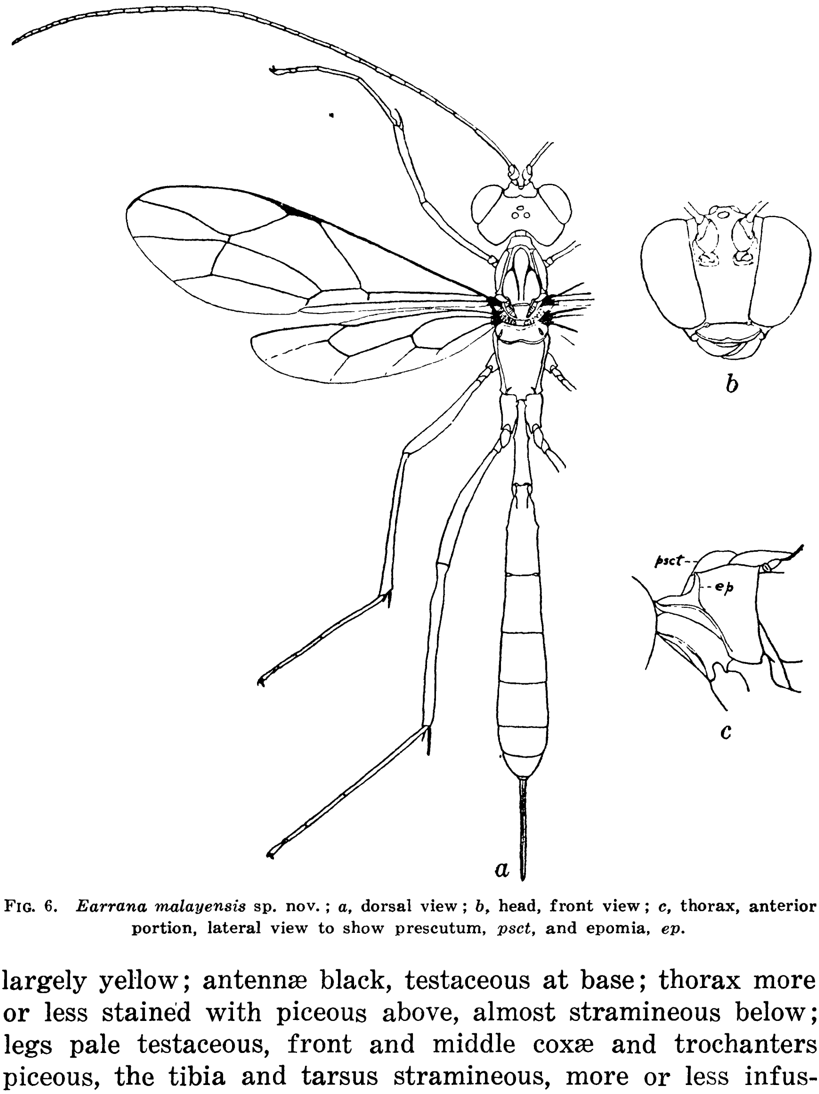

FIG. 6. *Earrana malayensis* sp. nov.; *a*, dorsal view; *b*, head, front view; *c*, thorax, anterior portion, lateral view to show prescutum, *psct*, and epomia, *ep*.

largely yellow; antennæ black, testaceous at base; thorax more or less stained with piceous above, almost stramineous below; legs pale testaceous, front and middle coxæ and trochanters piceous, the tibia and tarsus stramineous, more or less infuscated; wings hyaline, venation brown; abdomen more or less stained with piceous especially toward apex.

Type locality.—Singapore, Malay Peninsula.

Type.—Catalogue No. 24047, United States National Museum. Two females received from C. F. Baker.

Earrana philippinensis sp. nov.

Differing from *E. malayensis* sp. nov. principally in color. The male is selected as the type because of its much better con-

dition, the head of the female being broken off and glued to the double mount and the antennæ mostly missing.

Male.—Length, 13 millimeters. Antennæ stramineous, ferruginous at base; head not at all piceous and with the yellow color not extending above the antennæ; thorax ferruginous above without piceous stains; mesopleura and mesosternum stramineous; upper end of epomia strongly elevated, metapleura vertically wrinkled; stigma much paler than other venation; hind legs not at all piceous or fuscous; sheath nearly as long as first tergite from base to spiracle.

Female.—Agrees very closely with the male.

Type locality.—Philippine Islands, probably Luzon.

Type.—Catalogue No. 24048, United States National Museum.

Described from one male and one female collected by C. R. Jones.

Genus **ESUCHONEMATOPODIUS** novum

Differs from *Earrana* Cameron as follows: Head and thorax, especially the latter, strongly sculptured; posterior two-thirds of temples nearly flat and nearly perpendicular to axis of body; occipital carina obsoletely developed; vertex and frons strongly, sparsely punctate, becoming foveolate at side of frons; eyes weakly convergent below; face and clypeus punctate; latter indistinctly separated medially, not extending far laterally below eyes; thorax very coarsely punctate, becoming striate in middle of mesopleura; epomia fading out above far below dorsal margin of pronotum; front coxæ with a high carinate ridge in front; prescutum declivous anteriorly; lateral lobes each with a deep longitudinal furrow; mesosternum with an acute tubercle before each middle coxa; intercubitus obliterated, recurrent postfurcal; propodeum coarsely punctate, very sparsely so before basal carina; apical carina angulately prominent on each side; hind coxæ coarsely punctate above; abdomen subopaque, first tergite and base of second polished; first tergite nearly linear; spiracles barely protruding; spiracles of second tergite slightly behind middle; ovipositor sheath much longer than first tergite; sheath in male normal, not extending beyond apex of abdomen.

Type, *Esuchonematopodius luzonensis* sp. nov.

Esuchonematopodius luzonensis sp. nov.

Female.—Length, 12 millimeters; antennæ, 12; ovipositor, 3.5; front wing, 9. Face below three-fourths as broad as vertex; clypeus about half as long as wide, broadly rounded at apex; malar space as long as basal width of mandible, ocel-

locular line and width of ocellar triangle equal; first tergite scarcely wider at apex than at spiracles; second more than twice as long as wide at apex; others of rapidly decreasing length; ovipositor sheath nearly twice as long as first tergite.

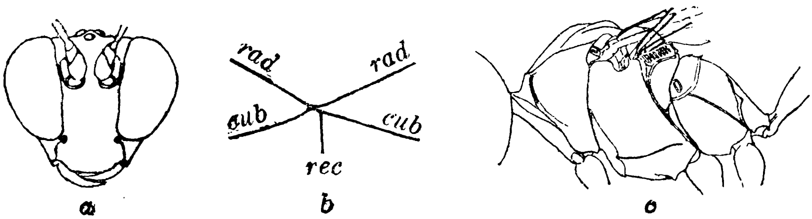

FIG. 7. *Esuchonematopodius luzonensis* sp. nov.; *a*, head, front view; *b*, venation in areolar region; *rad*, radius; *cub*, cubitus; *rec*, recurrent; *c*, thorax, lateral view.

Ferruginous; head and thorax below paler; legs testaceous, front pair and all coxæ paler; wings hyaline, venation brown; antennæ ferruginous.

Male.—Malar space somewhat narrower and antennæ paler than in the female; otherwise much the same.

Type locality.—Philippine Islands, probably Luzon.

Type.—Catalogue No. 24049, United States National Museum.

One female and three males collected by C. R. Jones and one female from Mount Maquiling, Luzon, collected by C. F. Baker.

Genus **MANSA** Tosquinet

Mansa TOSQUINET, Mem. Soc. Ent. Belg. 5 (1896) 209.
Colganta CAMERON, Ent. 35 (1902) 20.

This peculiar genus has much in common with the Palæarctic *Megaplectes* Foerster. The second joint of the maxillary palpus is even larger than in *Megaplectes* though not triangular; the head is of much the same form as that of *Megaplectes* though all of its features are exaggerated, as is frequently found to be the case in tropical genera closely related to genera of more northern range; the propodeum is similar but shorter and more strongly concave; the abdomen is shorter with the apical tergites relatively smaller; the venation, except for the unusual shape of the areolet, is very similar; and the long calcaria and large apical tarsal joints are almost duplicated in *Megaplectes.* In the new allied genus *Ceratomansa,* described below, the strong notauli and sternauli, almost lacking in *Mansa,* are almost exactly as in *Megaplectes.*

Seven specimens referable to this genus are at hand. Six from the Philippine Islands represent two closely related species,

apparently distinct from any of the described Oriental or Australian species. In a key that I have constructed from the descriptions of all of the species from these two regions the females of both species run to *M. fulvipennis* (Cameron) and the males to *M. volatilis* (Smith). Cameron's species, however, is from northern India and, moreover, is very meagerly described, the entire description being composed of the characters mentioned in a key to five species from that locality and a few others mentioned later in the description of *M. latiscutis* (Cameron). Cameron's description of the propodeal areolation of *M. fulvipennis* is rather obscure, but it is apparently more nearly complete than in the two Philippine species. (*Cryptus*) *Mansa volatilis* (Smith) from Mysol is described in the female and is said to have the antennæ black with a pale annulus, with which the present males agree but not the females. The seventh specimen is a female from Siam. It is very distinct by reason of its entirely black thorax and very dark wings.

The key mentioned above with the three new species inserted is reproduced below. It is based very largely on color because many of the species, notably Smith's and Cameron's northern Indian species, are described practically only by color.

Key to the Oriental and the Australian species of Mansa.

1. Black or largely black .... 2.
   Thorax black; head, abdomen, and legs rufous to ferruginous; wings very dark .... **M. bicolor sp. nov.** (Siam.)
   Ferruginous, fulvous or flavous, sometimes marked with black .... 3.
2. Wings fuscous; second tergite fuscoferruginous; basal half of antenna ferruginous; 16 millimeters, ovipositor 6.
   M. funerea Turner. (Indo-China.)
   Wings not fuscous; abdomen black with apical two tergites white-marked; antennæ black with joints 8 to 17 white beneath; 15 millimeters, ovipositor 4 .... **(Colganta) rufipes** (Cameron). (Borneo.)
3. Mesoscutum more or less black or blackish .... 4.
   Mesoscutum ferruginous .... 5.
4. Hind femora, tibiæ, and tarsi black; 15 millimeters, ovipositor about 3.
   (Colganta) nigro-maculata (Cameron). (Borneo.)
   Hind femora and tibiæ red; 15 millimeters.
   M. conformalis Tosquinet, female. (Java.)
5. Areolet not distinctly narrowed below, intercubiti straight; 12 millimeters, ovipositor 2.
   (Colganta) tuberculata (Cameron).[6] (Northern India.)
   Areolet narrowed below, the intercubiti oblique .... 6.
6. Hind tarsi not black, at most only slightly annulated with black or with apical joints only black .... 7.
   Hind tarsi black .... 13.

[6] The characters used constitute the entire description of this species.

7. Wings dark violaceous; antennæ blackish with dark fulvous annulus; 16 millimeters, male only.
(Colganta) **fulgidipennis** (Cameron).[7] (Northern India.)
Wings hyaline, suffused yellow or fulvous, rarely with a fuscous cloud behind stigma or at apex .... 8.
8. Antennæ flavous or ferruginous at base, broadly black at apex........ 9.
Antennæ black, yellow annulate .... 11.
9. Antennæ without white annulus; scutellum narrowed at apex with gradual slope; wings without a cloud; 12 millimeters, ovipositor 4.
(Colganta) **fulvipennis** (Cameron).[7] (Northern India.)
[The two Philippine species described below run here in the female, but have the propodeum less completely areolated. They can be separated from each other as follows:]
9a. Clypeus with a median, apical tooth; face very coarsely rugose-punctate laterally; frons coarsely punctate; scutellum with rather coarse, separated punctures; areolet not nearly twice as long beyond recurrent as before; inner spur of hind tibia barely reaching to middle of basitarsus .... **M. bakeri sp. nov.**
Clypeus without an apical tooth, medially narrowly impressed and emarginate; face at sides sparsely punctate; frons finely punctate; scutellum with fine confluent punctures; areolet about twice as long beyond recurrent as before; inner spur of hind tibia reaching distinctly beyond middle of basitarsus.
M. luzonensis sp. nov.
Antennæ tricolored with a whitish annulus........ 10.
10. Apical half of wing infumate; scutellum triangular; 17 millimeters.
M. pulchricornis Tosquinet, female. (Java and northern India.)
Wings entirely hyaline; scutellum broadly rounded at apex, apical slope abrupt; 17 millimeters, ovipositor 3.
(Colganta) **latiscutis** (Cameron). (Northern India.)
11. Costa black........ **M. conformalis** Tosquinet, male only. (Java.)
Costa ferruginous .... 12.
12. Wings without fuscous cloud behind stigma, which is entirely ferruginous; 7 lines; female only.
(Cryptus) **volatilis** (Smith). (Mysol.)
[The two Philippine species described below run here in the male, but the females lack the white antennal annulus. The males can be separated by the key given under couplet *9a* above.]
Wings with fuscous cloud behind stigma, which is margined with black.
M. volatilis subsp. **fumipennis** Turner. (Northern Queensland.)
13. Tibiæ black........ 14.
Tibiæ at most black at apex........ 15.
14. Length 12 millimeters; male only.
(Colganta) **tibialis** (Cameron).[8] (Northern India.)
Length 17 millimeters; ovipositor 5; female only.
(Colganta) **annulicornis** (Cameron). (Borneo.)

[7] The characters used in the key constitute the entire original description. This species was further described by Cameron in his description of *Colganta latiscutis*.
[8] The characters used constitute the entire description of this species.

15. Hind femur, apex of tibia and tarsus black; 12 millimeters; ovipositor 2 .... (Colganta) varicornis (Cameron). (Borneo.)
    Hind femur not black.. 16.
16. Wings apically infumate; 6⅓ lines; male only.
    (Cryptus) sicarius (Smith), male (=*Cryptus tarsatus* Smith, according to Cameron).[9]
    Wings not apically infumate; 12 millimeters; male only.
    (Colganta) tarsalis (Cameron).[8] (Northern India.)

Mansa bakeri sp. nov.

Female.—Length, 18 millimeters; antennæ, 18; ovipositor, 4.5; front wing, 15. Frons with sparse, obscure, large punctures on a granular surface, medially shallowly canaliculate; face medially slightly elevated, densely punctate, laterally irregularly transversely rugose; clypeus finely punctate, less densely so than middle of face, flattened, truncate at apex with a small median tooth; malar space longer than basal width of mandible; cheeks nearly straight; temples sparsely punctate; eyes prominent, parallel within. Thorax opaque above, subpolished laterally; pronotum densely punctate above, rugulose in the depression; mesoscutum and scutellum, the latter at sides as well as dorsally, very densely finely punctate and clothed with blackish hairs; notauli entirely absent; scutellum elevated, rounded behind in both dorsal and lateral views; mesopleurum shining, obscurely rugulose-punctate anteriorly, more strongly so ventrally; prepectus punctate, rugulose anteriorly; mesopleural furrow foveolate; sternauli broad, rugulose; sternum minutely punctate; metapleurum punctate anteriorly, merging into coarse vertical rugosity posteriorly, with posterior ventral corner separated by a sharp, curved carina; propodeum opaque granulate with more or less obscure rugosity, especially on posterior face, and with the rugosity of the metapleurum extending onto the lower posterior angle, median carinæ obsolete throughout, lateral carinæ obsolete anteriorly, strong posteriorly, basal carina entirely lacking, apical carina very strong at sides, wanting in middle, the propodeum medially impressed nearly its entire length, distinctly separated from metapleura only anteriorly, spiracle very long, occupying fully half the length of the space between base of propodeum and apical carina; hind coxa distinctly punctate, the tibia and tarsus equal in length; inner calcarium of hind tibia reaching barely to middle of basitarsus; areola much broader on radius than

[9] The female of *sicarius* Smith will run here if the tarsi are black, but the original description says nothing on this point.

on cubitus, first intercubitus strongly oblique, second nearly vertical, recurrent somewhat before the middle; nervellus strongly reclivous but not sharply broken. Abdomen smooth, without sculpture; postpetiole nearly or quite half as wide as entire first tergite is long, with a longitudinal furrow between the spiracles, flanked on either side by a shorter one.

Ferruginous, the head in front and thorax laterally slightly paler; basal three-fifths of antennæ fulvous, apex black; palpi flavous; legs testaceous, apices of hind tibia and tarsal joints slightly fuscous, apical joint rufous; wings uniform yellow hyaline; ovipositor sheath yellow.

Male.—Length, 12 millimeters; antennæ, 11; front wing, 12. Differs from female principally in the color of the antennæ and hind legs, the scape and pedicel being flavous, the flagellum black with the basal joints fulvous below and a pale annulus about the middle, the hind tibia with the apical half black, and the tarsus pale yellow; the sculpture is somewhat weaker.

A paratype female is like the type except in being somewhat smaller, in having the postpetiole slightly narrower, and the sculpture, especially of the propodeum and metapleurum, weaker.

Type locality.—Mount Maquiling, Luzon, Philippine Islands.

Type.—Catalogue No. 24050, United States National Museum.

Described from the above three specimens all received from Prof. C. F. Baker. The paratype female is from Los Baños, Luzon.

Mansa luzonensis sp. nov.

Closely allied to *M. bakeri* sp. nov. and differing principally as follows:

Female.—Length, 14 millimeters; antennæ, 14; ovipositor, 3.5; front wing, 12.5. Frons minutely, granularly punctate; sides of face only obscurely punctate; clypeus narrowly impressed and emarginate medially at apex; temples impunctate; pronotum as in *bakeri* but the rugulosity very weak; pubescence of mesoscutum and scutellum cinereous instead of black; mesopleurum and prepectus punctate but scarcely at all rugulose; sternauli punctate; metapleurum and propodeum less strongly rugose; carina of metapleurum nearly straight; propodeal carinæ on the whole more distinct but the apical carina and apical abscissa of lateral carina weaker; hind tarsus slightly longer than tibia, inner calcarium reaching distinctly beyond middle of basitarsus; recurrent vein at about the proximal third of areolet; first tergite slender, postpetiole not nearly half as wide as segment is long.

Colored like *bakeri* but with hind tibia and tarsal joints not black at apex, the tarsus distinctly paler than tibia.

Male.—Length, 10.5 millimeters; antennæ, 11; front wing, 10.5. Differs from female in color of antennæ and hind legs, the antennæ being black, pale at base and medially annulate, the hind tibia having its apical two-thirds black, and the tarsus being yellow with the basal joint narrowly black at base.

A paratype female is slightly smaller than the type.

Type locality.—Philippine Islands, probably Luzon.

Type.—Catalogue No. 24051, United States National Museum.

Described from the above three specimens, the type labeled "Acc. No. 771, Bur. Agr., P. I., collected by C. R. Jones;" the allotype male from Los Baños, Luzon (*Baker*); and the paratype female from Mount Maquiling, Luzon (*Baker*). The paratype is returned to Professor Baker.

Mansa bicolor sp. nov.

Very distinct by reason of its black thorax, red head, abdomen, and legs, and very dark wings. It is apparently closest to *funerea* Turner, which, however, has only the second tergite reddish and the ovipositor relatively shorter.

Female.—Length, 19 millimeters; antennæ (extreme tips gone); ovipositor, 8; front wing, 16. Frons finely granulate, medially punctate and canaliculate; face medially elevated and coarsely, densely punctate, laterally reticulate-rugose; clypeus distinctly separated from face by elevation, coarsely and sparsely punctate, broadly truncate at apex and with the margin medially slightly reflexed; malar space distinctly longer than basal width of mandible; cheeks coarsely punctate, the punctuation gradually weaker dorsally until on posterior slope of vertex it disappears entirely. Thorax coarsely sculptured; pronotum dorsally and mesoscutum densely punctate, scutellum less densely so and polished; pronotum below, mesopleurum, metapleurum, and propodeum reticulate-rugose; propleura polished, sparsely and obsoletely punctate; mesosternum more finely and less densely punctate than mesoscutum; notauli entirely wanting, sternauli practically so; scutellum elevated, margined only at extreme base; propodeum with lateral and pleural carinæ complete, the first curving forward in middle nearly to base, no traces of basal carina present, lateral especially strong above spiracle; areolet much broader on radius than on cubitus, first intercubitus very strongly oblique and curved, second nearly perpendicular and straight, second recurrent much nearer base than apex;

nervellus strongly broken, lower abscissa strongly oblique, upper nearly perpendicular. Abdomen polished, second tergite very finely punctate; first tergite a third as wide at apex as long, its surface smooth, without furrows or other sculpture.

Thorax, coxæ, tegulæ, and apical half of antennæ black; head, basal half of antennæ, and legs ferruginous to testaceous; ovipositor black, sheath pale ferruginous; wings very dark.

Type locality.—Trong, Lower Siam.

Type.—Catalogue No. 24052, United States National Museum. One female, W. L. Abbott, collector.

Genus **CERATOMANSA** novum

This genus is closely allied to *Mansa* Tosquinet; the most striking differences are indicated in the following key:

1. Frons shallowly concave, unarmed; vertex deeply concave; antennæ stout, especially beyond middle, apex blunt; maxillary palpi very long, reaching far beyond apex of front coxæ; notauli practically wanting; sternauli weak; basal carina of propodeum wanting; legs stout, hind tarsi not white annulate .... **Mansa** Tosquinet.

   Frons deeply concave, with a strong median compressed horn; vertex nearly level with top of eye; antennæ slender, barely thickened beyond middle, attenuate at apex; maxillary palpi barely reaching apex of front coxæ; notauli and sternauli strong; basal carina of propodeum strong; legs, especially the tarsi, slender, hind tarsi black with third and fourth joints white .... **Ceratomansa** g. nov.

In addition to the characters given in the key, *Ceratomansa* differs from the three species of *Mansa* described on preceding pages as follows: Slenderer; head and thorax less strongly sculptured; face impressed on each side of middle; malar space not longer than basal width of mandible; prepectal carina complete; speculum partly striate; apical tarsal joint much shorter than third; areolet much smaller, scarcely half as long on radius as basal abscissa of radius, second recurrent beyond middle; discocubitus slightly angulate; nervulus antefurcal; postnervulus strongly broken; basal abscissa of discoideus much more than twice as long as nervulus.

Type, *Ceratomansa prima* sp. nov.

Ceratomansa prima sp. nov.

Female.—Length, 15 millimeters; antennæ, 18; ovipositor, 5; front wing, 14. Temples, cheeks, face, and clypeus coriaceous, last two opaque and sparsely punctate; frons subpolished and somewhat irregularly rugulose; vertex punctate; upper inner orbits swollen; vertex precipitous behind; occipital carina very

strong, especially medially; ocellocular and postocellar lines equal, diameter of lateral ocellus slightly shorter; eyes large, bulging, parallel within, much longer than width of face; malar space barely as long as basal width of mandible; clypeus distinctly separated from face, as long as interfoveal line, broadly truncate at apex; mandibles short, teeth blunt, upper larger and very slightly longer than lower; apical joint of maxillary palpus only slightly shorter than fourth. Thorax largely finely densely punctate; pronotum rugose below, epomia strong but not reaching upper margin; scutellum shining, sparsely punctate, margined only at base, fovea with several longitudinal rugæ; mesopleurum largely rugose above, speculum elevated and polished only behind, the anterior part embraced by the rugosity; sternauli incomplete behind but deep and partly foveolate, the posterior end curving suddenly upward; propodeum punctate before and reticulate-rugose behind basal carina, weakly concave on posterior slope, pleural carina obsolete, being largely replaced by a foveolate groove, apical carina prominent laterally; coxæ punctate, especially posterior pair. Abdomen beyond first tergite very finely shagreened; first tergite polished, petiole slender, tergite and sternite completely fused, postpetiole at apex about three times as wide as narrowest part of petiole, spiracles slightly nearer to each other than to apex, petiole flattened above, the flattening becoming a slight impression between the spiracles; ovipositor slender.

Ferruginous; head black, inner orbits, face except impressions, cheeks, indistinct line on posterior orbits, clypeus, mandibles except apices, and palpi largely whitish; antennæ black with a ventrally incomplete white annulus on flagellar joints 7 to 14; upper margin of pronotum, tegulæ, wing bases, scutellar carinæ, prepectus and subalar tubercle, and posterior margin of mesopleurum luteous; legs testaceous, apical tarsal joints on all legs, basal two joints of hind tarsus, and apices of its tibia and femur black; wings hyaline, slightly stained with yellow, venation black, stigma white at extreme base; tergites 2 and 3 slightly stained with blackish at sides; ovipositor sheath black.

Type locality.—Shoalhaven, New South Wales.

Type.—Catalogue No. 24053, United States National Museum. One female (G. W. F., 1895).

Genus **HEMIGASTER** Brullé

Only five species from the Oriental and Australian Regions have been described in this genus; and one of these, *H. jacobsoni*

Szépligeti from Java, is certainly misplaced. It properly belongs in the genus *Syrites* Tosquinet, where it is very closely related to the Philippine (*Astomaspis*) *Syrites metathoracica* (Ashmead). None of the other four species is available for study, but the two new species, one from Singapore and one from the Philippine Islands, described below, are apparently distinct from either, as indicated by the following key which includes all six species:

Key to the Oriental and the Australian species of Hemigaster.

1. Luteous, vertex and back of abdomen red.
   H. luteus Brullé. (Australia.)
   Ferruginous .... 2.
2. Notauli present .... 3.
   Notauli absent .... 5.
3. Hind tarsi pale .... H. carinifrons Cameron. (Assam.)
   Hind tarsi black .... 4.
4. Second tergite with a broad black band at base; sides of face and of vertex brown .... H. fasciatus Brullé. (East Indies.)
   Immaculate ferruginous .... H. malayensis sp. nov. (Singapore.)
5. Mesoscutum with three fuscous marks; wings apically infuscate.
   H. insularis Roman. (Philippine Islands.)
   Mesoscutum immaculate; wings yellowish hyaline, paler at apex.
   H. bakeri sp. nov. (Philippine Islands.)

Hemigaster malayensis sp. nov.

Female.—Length, 9 millimeters; antennæ, 8.5; front wing, 7.5. Vertex laterally with large, rather sparse punctures, which merge anteriorly into the irregular rugosity of the sides of frons; interocellar space opaque, without distinct sculpture; margined only at sides, the carinæ merging into the general sculpture above; median horn thick and canaliculate on dorsal edge, bilobed at apex; face and clypeus reticulate-rugose, more coarsely so at sides, elevated in middle; clypeus without a median apical tooth; cheek and lower temple transversely rugose, this fading out to fine, rather dense punctuation at the middle of the eye. Pronotum rather finely punctate above, coarsely foveolate in ventral angle and along anterior and posterior margins; mesoscutum rather finely, very densely punctate, notauli distinct to middle, prescutum with a median groove anteriorly; scutellum sculptured like the mesoscutum, tapering to the very narrow apex, and with strong lateral carinæ extending to the apex; mesopleurum densely rugulose with an oblique, transversely striate area in the middle; anterior and posterior furrows foveolate; prepectal carina approaching anterior margin gradually;

sternaulus deep, complete, and strongly foveolate; mesosternum with a rounded tubercle in front of mesocoxæ but with no ridge running forward from these; metapleurum rather finely rugulose-punctate; propodeum irregularly reticulate-rugose at sides, subpolished and transversely striate medially, carinæ strong and thin, especially the apical carina which is high and flangelike but without distinct apophyses, propodeal area concave, separated from posterior lateral only by difference in sculpture; discocubitus broken; nervellus broken nearly at a right angle; hind coxa without a carina on its exterior dorsal margin; inner calcarium of hind tibia reaching distinctly beyond middle of basitarsus; abdomen finely, densely punctate, first tergite polished at base and with the median dorsal carina distinct and well separated to base; third tergite strongly rounded at apex; ovipositor as long as second tergite.

Ferruginous with short, golden, appressed pubescence; face stramineous; flagellum blackish, brownish at base, especially beneath, with an incomplete whitish annulus dorsally occupying joints 4 to 8; wing slightly smoky, costa and stigma light brown, other veins blackish; legs testaceous; front and middle coxæ and trochanters stramineous; hind femur and tibia at apex, hind tarsus entirely, and apical joints of other tarsi black; calcaria reddish; ovipositor sheath black.

Male.—Very similar to female but with the antennal annulus smaller and less distinct and the stigma largely blackish.

Type locality.—Singapore, Malay Peninsula.

Type.—Catalogue No. 24054, United States National Museum.

Described from two females and two males, all received from C. F. Baker.

There is considerable variation in size, the largest female, the type, being 9 millimeters long and the smallest male, paratype *b*, only 5.5.

Hemigaster bakeri sp. nov.

Female.—Length, 12 millimeters; antennæ, 10; front wing, 9. In addition to being larger, differs from *malayensis* as follows: Vertex laterally densely reticulate-punctate, the sides of the frons more coarsely but not differently sculptured; interocellar space with a few large punctures; frontal concavity margined nearly to middle above, the carina high and sharp and sending a branch carina dorsally where it begins to arch over the concavity; median horn very thin on dorsal edge, not

bilobed at apex; face at sides and clypeus coarsely transversely rugose-punctate, more finely so toward middle and with a narrow unsculptured median line; clypeus with a small median tooth at apex; cheeks with coarse, separated punctures becoming smaller and sparser on temples where they gradually disappear. Pronotum coarsely punctate above, otherwise as in *malayensis;* mesoscutum more coarsely punctate, notauli and median groove of prescutum wanting; scutellum sculptured like mesoscutum, narrow at apex, obscurely margined only at base; mesopleurum coarsely punctate, the striate area of *malayensis* here replaced by a smooth polished area, anterior furrow obscure, not foveolate; prepectal carina bending sharply toward anterior margin shortly above level of ventral angle of pronotum; sternaulus deep anteriorly but fading out shortly behind middle of pleurum, not foveolate; mesosternum with a ridge running forward from the antecoxal tubercle; metapleurum coarsely rugose-punctate; propodeum medially punctate, carinæ mostly rather weak but with distinct apophyses that are fully as high as their basal width, propodeal area only slightly concave, separated from posterior lateral by distinct carinæ; discocubitus not broken; nervulus not triangularly broadened at its lower end; nervellus broken at a very wide angle, hind coxa with a high, sharp carina on its exterior dorsal margin; inner hind calcarium barely reaching middle of basitarsus. Abdomen more coarsely punctate, especially on petiole, which is polished only at extreme base, the median dorsal carinæ almost contiguous on the petiole and nearly obliterated by the coarse sculpture; third tergite broadly rounded at apex; ovipositor as long as second tergite.

Colored like *malayensis* except that the wings are yellowish hyaline, the hind femur not black at apex, the hind tarsus yellow with the apical joint reddish, and the ovipositor sheath reddish at base.

Male.—Differs from female practically only in having the basal two-thirds of the antennæ ferruginous with only the faintest indication of the annulus.

Type locality.—Los Baños, Luzon, Philippine Islands.

Other localities.—Mount Maquiling and Mount Banahao, Luzon, Philippine Islands.

Type.—Catalogue No. 24055, United States National Museum.

Described from three females and two males, all received from C. F. Baker. Only slight variation in size is displayed by the type series.

Genus **ROTHNEYIA** Cameron

Three species have been referred to this genus by Cameron, all from India, while Schmiedeknecht records one of them also from Java. The second species described, *annulicornis* Cameron, differs so markedly in structural characters from the others that one wonders, not having examined it, if it is properly placed in the genus. These differences are brought out in the following key to the species. The new species tabulated and described below is apparently typical of the genus.

Key to the species of Rothneyia.

1. Third tergite not toothed at apex; flagellum white-annulated; separation between second and third tergites obscure; scutellum without teeth, simply margined .... **R. annulicornis Cameron.**
   Third tergite toothed at apex; flagellum not white-annulated; separation between second and third tergites distinct; scutellum with teeth at apex .... 2.
2. Petiole ferruginous .... **R. wroughtoni Cameron.**
   Petiole black........ 3.
3. Antennæ longer than body........ **R. fortispina Cameron.**
   Antennæ shorter than body........ **R. insularis sp. nov.**

Rothneyia insularis sp. nov.

Male.—Length, 6 millimeters; antennæ, 4.5; front wing, 4.5. Head transverse, in front view roundly triangular, temples slightly convex, sharply sloping; frons with large, separated punctures, the middle narrowly polished, impunctate; vertex very sparsely punctate; face densely, confluently punctate, becoming striately so in middle; clypeus sparsely punctate, not separated from face by a furrow but by difference in sculpture, longer than face, gently convex and rather sharply rounded at apex; malar space two-thirds as long as basal width of mandible; eyes convergent to level of antennæ, thence parallel, slightly sinuate above antennæ; antennæ distinctly shorter than body, basal three joints of flagellum subequal and each scarcely longer than scape, the flagellum attenuate at apex; postocellar and ocellocular lines equal and distinctly longer than diameter of ocellus. Thorax opaque dorsally and ventrally, shining laterally; pronotum polished with a few rugæ posteriorly and sparsely punctate above, epomia distinct but fading out below dorsal margin; mesoscutum densely punctate, notauli distinct anteriorly, lateral lobes flanked by a deep groove laterally; scutellum rugose, posterior angles very high and prominent, apical slope abrupt, with a few longitudinal rugæ, lateral areas polished,

foveolate above and below; mesopleurum polished in middle, rugulose-punctate dorsally and anteriorly, mesopleural furrow foveolate, prepectal carina very sharp, curving backward below the front wing to join the carinate dorsal margin of the pleurum; sternauli complete, deep and broad anteriorly; sternum densely punctate, median furrow very broad and deep; propodeum and metapleurum irregularly rugose; basal area confluent; spiracle round, situated on a raised area; apophyses very prominent; pleural carinæ and costellæ obscured by sculpture; nervulus interstitial; areolet higher than long, intercubiti slightly convergent above; bullæ large, second intercubitus largely hyaline; nervellus strongly inclivous, broken at lower fourth. Abdomen coarsely reticulate-rugose; first tergite as wide at apex as long, median carinæ convergent beyond middle, not attaining the apex but becoming obscured by the sculpture, spiracles subtuberculate; second and third tergites separated by a distinct suture, third with prominent apical angles.

Black; antennæ toward base and palpi brownish; front and middle legs brownish piceous, their tibiæ and tarsi pale; hind legs darker; wings hyaline, immaculate.

Type locality.—Los Baños, Luzon, Philippine Islands.

Type.—Catalogue No. 24056, United States National Museum.

Described from one male collected by C. F. Baker.

Genus **SYRITES** Tosquinet

Syrites TOSQUINET, Mem. Soc. Ent. Belg. 10 (1903) 117.
? *Camptolynx* CAMERON, Berl. Ent. Zeit. 55 (1910) 252.

I am somewhat doubtful of the synonymy of *Camptolynx*. Cameron states that in the male this genus has the spines on the fourth tergite. In *Syrites* they are on the third. Aside from this Cameron's description is very like *Syrites*, and it may be that he was mistaken as to the location of the spines or that there is variation within the genus in this respect.

Acanthoprymnus Cameron, from South Africa, synonymized by Schmiedeknecht with *Syrites*, seems not to be the same genus. It is described in the female as having spines on the third tergite, a character not found in the female of *Syrites*.

The peculiar structure of the abdomen in the male and the marked sexual antigeny have led to the description of species properly placed here in no less than seven genera. All are from the Australian and Oriental Regions.

The following key is based on the descriptions of all of the Australian and Oriental species that I have been able to identify

as probably belonging to this genus and material of two species from the Philippines. Because the color has as a rule been more carefully described, practically all of the characters used are color characters. It should be noted, however, that the color, especially of the thorax, is variable in both sexes. There seems very little reason to doubt that several of the species will have to sink into synonymy. Thus I strongly suspect that *jacobsoni* and *bidentatus* of Szépligeti will prove to be synonymous with *metathoracica* (Ashmead), as *striatus* (Ashmead) undoubtedly is.

Key to the species of Syrites.

1. Males .... 2.
   Females .... 7.
2. Abdominal spines on fourth tergite .... 3.
   Abdominal spines on third tergite .... 4.
4. Thorax ferruginous and black .... 5.
   Thorax usually entirely black .... 6.
5. Mesopleura ferruginous.
   (Camptolynx) froggatti (Turner). (Australia.)
   Mesopleura black .... **(Hemigaster) jacobsoni** (Szépligeti). (Java.)
6. Only the first tergite pale; mandibles black; propodeal spiracles rather large .... **S. acanthogaster** Tosquinet. (Sumatra.)
   Both first and second tergites pale; mandibles pale; propodeal spiracles small.
   (Astomaspis) metathoracica (Ashmead) (=*Bathythrix striatus* Ashmead). (Philippine Islands.)
7. Thorax black .... **(Camptolynx) ruficornis** (Turner). (Australia.)
   Thorax ferruginous or partly so .... 8.
8. Hind tibia with a distinct pale annulus in the middle, second and third tergites each with a narrow transverse subapical furrow, which with a reversely curved basal furrow set off a distinct median area.
   S. arealis sp. nov. (Philippine Islands.)
   Hind tibia without such an annulus; transverse furrow of second and third tergites broad and shallow, basal furrows obsolete .... 9.
9. Both front and hind wings with fuscous band.
   (Camptolynx) froggatti (Turner). (Australia.)
   Only the front wings maculate .... 10.
10. Front wing clouded from base to basal vein.
    (Hemiteles) bidentatus (Szépligeti). (Java.)
    Front wing hyaline at base .... 11.
11. Hind tarsus narrowly pale at base.
    (Camptolynx) striatus (Cameron). (Ceylon.)
    Hind tarus entirely black .... 12.
12. Thorax black before, ferruginous behind; clypeus yellow; scape and pedicel black .... **(Ischnocerus?) cancellatus** (Brullé). (Java.)
    Thorax usually entirely ferruginous, rarely with mesoscutum and pronotum blackish; clypeus at most fuscoferruginous; scape and pedicel stramineous below.
    (Astomaspis) metathoracica (Ashmead). (Philippine Islands.)

(Hemigaster) Syrites jacobsoni (Szépligeti).

Notes Leyden Mus. **29** (1908) 245, male.

This Javanese species is apparently so closely allied to *S. metathoracica* (Ashmead) that a male of the latter species compared with Szépligeti's description differs only in having the thorax and propodeum entirely black and the nervellus distinctly antefurcal.

(Hemiteles) Syrites bidentatus (Szépligeti).

Notes Leyden Mus. **29** (1908) 252, female.

This species, also from Java, is very likely the female of *S. jacobsoni* (Szépligeti). Szépligeti is the only one who has mentioned the lateral angulations on the third tergite in the female, but the analogy between these and the spines on the male escaped him.

(Ischnocerus?) Syrites cancellatus (Brullé).

Hist. Nat. Ins., Hym. **14** (1846) 262, female.

In the preceding key I have separated *S. bidentatus* (Szépligeti) from this and two other species on account of the clouded base of the wing. As a matter of fact Brullé makes no mention of this, describing the wing simply as having an incomplete brown band; and I suspect that Szépligeti has redescribed Brullé's species, especially as they are from the same island.

Syrites acanthogaster Tosquinet.

Mem. Soc. Ent. Belg. **10** (1908) 118, male.

This Sumatran species seems to be distinct from the rest in having only the first tergite red, the mandibles black, and the propodeal spiracles large and slightly oval; it may be that I am wrong in referring the other species to *Syrites*, but in all other respects Tosquinet's description accords so well with the male of *S. metathoracica* (Ashmead) that it seems impossible that they are not congeneric.

(Camptolynx) Syrites ? fuscipennis (Cameron).

Berl. ent. Zeit. **55** (1910) 253, male.

This and the following species, both from Ceylon, are the basis of Cameron's genus. Because of the stated position of the spines on the fourth tergite instead of the third they are, as stated above, doubtfully referred to *Syrites*, and Cameron's genus is doubtfully synonymized with *Syrites*.

(Camptolynx) Syrites ? quadrispinosus (Cameron).

Berl. ent. Zeit. 55 (1910) 253, male.

The status of this species is discussed under the next preceding.

(Camptolynx) Syrites striatus (Cameron).

Berl. ent. Zeit. 55 (1910) 254, female.

Regardless of whether or not *Camptolynx* is synonymous with *Syrites* there can, I think, be no doubt that this Ceylonese species is a *Syrites* although a comparison of the descriptions of this and *S. quadrispinosus* almost leads to the conviction that they are the sexes of the same species.

(Camptolynx) Syrites froggatti (Turner).

Ann. & Mag. Nat. Hist. IX 4 (1919) 41, female and male.

In having the hind as well as the front wings banded this Australian species is apparently distinct from all of the others.

(Camptolynx) Syrites ruficornis (Turner).

Ann. & Mag. Nat. Hist. IX 4 (1919) 42, female.

The entirely black thorax and propodeum, unusual in the female, renders this species very distinct. It is from Australia.

(Astomaspis) Syrites metathoracica (Ashmead).

Astomaspis metathoracica ASHMEAD, Proc. U. S. Nat. Mus. 28 (1904) 140, female.

Bathythrix striatus ASHMEAD, op. cit. 141, female.

Acanthohemiteles benjamini Ashmead manuscript, BROWN, Philip. Journ. Sci. 1 (1906) 692.

In spite of its broken nervellus and complete notauli, and in spite of the fact that the clypeus and mandibles do not agree with Foerster's description, Ashmead placed the unique type of *metathoracica* in *Astomaspis,* to which genus it was the first species referred. Because of these disagreements with the original description it cannot be the genotype of *Astomaspis.* Nor is it at all closely related to the accepted genotype, *Astomaspis nanus* (Gravenhorst), first assigned to the genus in 1910 by Roman.

On the page following the description of *metathoracica* Ashmead described another specimen, of the same species, as *Bathythrix striatus,* placing it in that genus despite its obvious disagreement with the genotype, *Bathythrix meteori* Howard, the type specimen of which was in the collection over which he

had charge. The name *metathoracica* is unfortunately chosen, for the color character on which it is based is not conspicuous and is an apparently rather rare variation, the thorax being usually entirely ferruginous.

What I take to be the male of this species is represented in the National Museum collection by four specimens, all taken at Manila, Philippine Islands, by Rev. Robert Brown. These are the *Acanthohemiteles benjamini* Ashmead manuscript, of Brown's list of Philippine Hymenoptera. There are also nine additional females taken at the same place by the same collector. Aside from the very different abdomen the male differs from the female principally in having the thorax black or largely black. In one of the four specimens examined the propodeum is piceorufous. In the female the third and fourth tergites are subangulate laterally at apex.

Syrites arealis sp. nov.

Differs from *S. metathoracica* (Ashmead) and apparently from all of the other described species in the structure of the second and third tergites, the usual transverse furrow meeting laterally the extremities of a basal reversely curved furrow, the two setting off a transverse median area.

Female.—Length, 5 millimeters; antennæ, 4. Slenderer than *S. metathoracica* (Ashmead). Head distinctly broader than thorax; temples strongly convex; vertex with striæ radiating in all directions from ocelli, a deep short groove between the lateral ocelli; frons transversely, arcuately striate; face finely, confluently punctate, elevated medially; clypeus punctate, medially irregularly striate; face, clypeus, and cheeks clothed with moderately dense white pubescence; temples and cheeks irregularly vertically striate, posterior orbits punctate; malar space nearly as long as basal width of mandible. Thorax subopaque; pronotum with the lateral furrow deep, subpolished, the dorsal portion somewhat swollen and obliquely striate; mesoscutum obscurely transversely striate, each lobe with a median opaque streak; scutellar fovea deep and foveolate but not distinctly carinately margined before and behind; scutellum reticulate punctate, margined laterally to middle; mesopleurum, metapleurum, and propodeum with long white pubescence, the pleura confluently, almost rugosely punctate; propodeum irregularly rugulose, the basal areas not defined, areola hexagonal, removed from base by its own length, lateral carina distinct only beyond apical carina, petiolar area nearly vertical, shorter than dorsal

face of propodeum, spiracles small, round; apical abscissa of radius slightly decurved; discocubitus subangulate at about its basal third; nervulus barely antefurcal; nervellus inclivous, broken below middle; hind tibia strongly compressed, as broad as femur. First four tergites striate, others polished, fifth weakly striate at base; first distinctly longer than wide at apex, spiracles just behind middle; second and third tergites each with a transverse area set off by basal and subapical curved furrows; fifth constricted near base; ovipositor less than half as long as first tergite.

Ferruginous, with head and abdomen beyond second segment black; antennæ brown, scape and pedicel testaceous; mandibles pale, the oral margins more or less red; palpi stramineous; tegulæ and humeral angles stramineous, radices of wings and base of stigma white; wings hyaline, the front wing weakly stained to basal vein, with a broad dark band across the broadest part, and a small obscure spot on the nervulus; hind wing immaculate; legs testaceous, hind femur largely piceous, tibia fuscous, with a white basal annulus and obscurely pale in the middle, tarsus fuscous; middle tibia with same color pattern obscurely developed; tergites beyond second piceous black.

Type locality.—Manila, Philippine Islands.

Type.—Catalogue No. 24057, United States National Museum. One female taken by Rev. Robert Brown.

Genus CHRYSOCRYPTUS Cameron

The species described below is apparently very closely allied to, if not the same as, the undescribed male referred by Roman [10] to this genus and on the strength of which that author synonymized Cameron's genus with *Leptocryptus* Thomson, especially the subgenus *Panargyrops* Foerster. Roman was of the opinion that Cameron mistook the costellæ for the spiracles.

The species before me differs in several respects from Cameron's description, as follows: The spiracles are round instead of linear; the ovipositor sheath is clothed with black instead of white hair; the first three joints of the flagellum are not four times as long as thick; the discocubitus is angulate and with a very short ramellus; the clypeus is distinctly tridenticulate at apex; the areola is not rounded at base; and the radius is not thickly pilose at base. From the genotype as described it differs markedly also in being entirely bright ferruginous with the legs uniformly testaceous and the wings entirely hyaline. Because of these differences I refer it very doubtfully to *Chrysocryptus*.

[10] Arkiv. Zool. 8 [15] (1913) 9.

It is certainly very closely allied to *Panargyrops*. The position of the propodeal spiracles far in front of the costellæ is very characteristic, and together with the long pubescence and general habitus indicates the close relationship. I would not, however, go so far as to place it in *Panargyrops* because of the very broad, unseparated, tridentate clypeus and the very long upper tooth of the mandible.

Chrysocryptus ? romani sp. nov.

Both generic and specific characters are given in the following description:

Female.—Length, 12 millimeters; antennæ, 7; ovipositor, 7; front wing, 10. Entire body polished and practically without sculpture, clothed with long, mostly erect, golden pubescence, this embracing also the coxæ, trochanters, and femora especially of the hind legs, and the wings especially the costa (on the wings the pubescence is blackish).

Head transverse; the temples convexly sloping; vertex broad, elevated above level of top of eyes; occipital carina strong, gradually fading out on lower cheeks; head in front view transverse; eyes very large, prominent, convergent below; malar space almost obliterated; face more than twice as broad as long, slightly impressed on each side below antennæ, its pubescence subappressed; clypeus much longer than face, very weakly separated, lateral angles and foveæ nearly touching the eyes, nearly flat with apex broadly rounded and with three distinct denticles in the middle; mandibles large, slightly tapering and with the upper tooth much longer than the lower; palpi rather short, slender, the apical two joints of maxillary palpi together but little longer than third; antennæ rather slender, slightly stouter beyond middle and tapering toward apex; apex of scape only slightly oblique; flagellar joints becoming gradually shorter from basal, which is about three times as long as thick. Thorax small, narrower than head, much smaller behind; notauli strong and terminating abruptly, without joining, shortly before the scutellar fovea; pronotum practically without pubescence, with a short foveolate groove at lower angle, epomia strong but short; prescutum sharply defined, the carina emarginate opposite the sternauli, wihch are very deep anteriorly but become obsolete posteriorly; mesopleural furrow foveolate above; metapleurum separated from sternum by a high carina, from the anterior end of which a short carina extends obliquely onto the pleurum;

scutellum convex, immargined; postscutellum long, bifoveolate at base; propodeum completely areolated, all the carinæ high and sharp; areola large, coffin-shaped, longer than petiolar area; spiracle round, situated far before the costella and nearer the lateral than the pleural carina; apex of propodeum extending distinctly over the bases of hind coxæ; wings large; stigma narrow, lanceolate; discocubitus angularly broken and with a very short ramellus, its bulla small and nearer the ramellus than the intercubitus; areolet nearly equilaterally pentagonal, the second intercubitus largely bullated; second recurrent curved outward, meeting the subdiscoideus at nearly a right angle, its bulla large and uninterrupted; nervulus interstitial; nervellus reclivous, broken at about the middle; radiella becoming obsolete shortly beyond intercubitella, cubitella entirely so; legs very slender, hind tibia about as long as thorax; front tarsus longer than, hind tarsus as long as, their tibiæ, claws and calcaria small. Abdomen subclavate; first tergite very narrow throughout, compressed, completely fused with sternite, without carinæ, spiracles distinctly before middle; second tergite about twice as long as wide at apex, nearly three times as wide at apex as at base, in lateral view concave above, with an obsolete carina running from base to spiracle; first tergite and base of second polished and with sparse erect pubescence, abdomen otherwise with dense subappressed pubescence in addition to the erect; apical tergite elongate, trowel-shaped; ovipositor slender, nearly as long as abdomen, the sheath with black pubescence.

Bright ferruginous, the face slightly paler; flagellum blackish, paler at base; legs testaceous, the tarsi slightly infuscated; wings hyaline, venation brown; ovipositor sheath black.

Male.—Like the female in almost every respect, but with the front and middle legs stramineous.

Type locality.—Mount Maquiling, Luzon, Philippine Islands.

Type.—Catalogue No. 24058, United States National Museum.

Described from one female and one male received from Prof. C. F. Baker.

I take pleasure in dedicating this beautiful and interesting species to Dr. A. Roman, of Stockholm.

Genus **APOPHYSIUS** novum

This very curious genus is anomalous wherever placed. Owing to the strongly compressed abdomen it has a superficial ophionine appearance, but the form of the areolet, and the sternauli preclude its being placed in the Ophioninæ. Aside from the compression of the abdomen most of the customarily used characters ally it with the Cryptinæ. The extremely broad

areolet is unusual though not unique in the Cryptinæ, that of *Protocryptus* Schmiedeknecht being very similar. In the Cryptinæ the completely defined areolet and areolated propodeum place it in the Phygadenonini, where it seems to me less discordant than in any other placing. Here the narrow first tergite with spiracles placed in the middle is almost duplicated in *Thysiotorus* Foerster as represented by *T. lamina* (Thomson) and in *Panargyrops* Foerster. These two genera also have the bidentate clypeus and the silky pubescence of the head; while in *T. lamina* the shape of the head and the relative length of the basal flagellar joints, though slenderer, are not very different. Except that the areolet is much broader and the stigma narrower with the radius originating near its base, the venation of the present genus differs in no essential particular from that of *Panargyrops*. If couplet 3 in Ashmead's key to the Phygadenonini, the character in which can hardly be considered of generic value, be omitted, the genus runs to *Panargyrops*, though not agreeing with the last sentence. From either of these genera it is at once distinguished by the structure of the propodeum, the compressed abdomen, and the shape of the areolet.

Head from above strongly transverse with temples very narrow; from in front very broadly transverse, subtriangular; eyes large, bulging, convergent below, malar space very short; clypeus separated by elevation, bidentate at apex, mandibles bidentate, upper tooth larger and longer; scape short, subglobose, flagellum tapering at apex, first joint much longer than second; entire body, including legs, and especially the head and thorax clothed with long, silvery hairs; pronotum short, polished, with lower angle foveolate, epomia fairly strong, sharply curved; mesoscutum flattened, polished, notauli obsolete, each lateral lobe with a deep, broad, longitudinal furrow, prescutum with two parallel shallow furrows; scutellum strongly convex, not margined, basal fovea very broad and deep; postscutellum bifoveate at base; mesopleurum polished, wide in upper portion, prepectus broad below, ending above not far above ventral angle of pronotum, sternauli broad and shallow and extending about half the length of mesopleurum, subalar tubercle carinate at top; propodeum short, sloping from base, completely areolated, the intersections of the lateral carina with each of the transverse carinæ forming a prominent apophysis, the posterior one long and slender, the anterior one large and triangular in outline, embracing the entire basal abscissa of the lateral carina, and

opposed on the metapleurum by a pyramidal apophysis, each basal lateral area bearing a prominent tubercle opposed on metapostnotum by a sharp point, areola small, wider before than behind; petiolar area very narrow in front, wider behind, the apical portion of the median carinæ very high and thin, spiracles elongated oval; metasternum very short, the middle and hind coxæ very close together; legs long and slender, claws small, simple; wings large, stigma narrow with radius distinctly before middle, apex of radius far before apex of wing, areolet much broader on radius than high, intercubiti parallel, second mostly bullated, discocubitus angulated in middle, nervulus interstitial, basal abscissa of radiella and intercubitella subequal in length, nervellus reclivous, broken in middle; apical abscissæ of all longitudinal veins in hind wing obsolete except small portion of radiella; abdomen strongly compressed beyond second tergite, polished; first tergite slender, scarcely widened at apex, spiracles in middle, prominent; second tergite a little wider at base than first at apex, more than twice as long as wide, nearly parallel-sided, spiracles shortly before middle; ovipositor sheath about as long as first tergite.

Type, *Apophysius bakeri* sp. nov.

Apophysius bakeri sp. nov. Plate 1.

Female.—Length, 10.5 millimeters; antennæ, 8.5; ovipositor, 1.5; front wing, 9. Head from in front fully two-thirds broader than long; malar space nearly obliterated; clypeus slightly broader than long; face below about two-thirds as broad as vertex, latter broader than greatest diameter of eye; ocellocular line longer than width of ocellar triangle; ocelli large, diameter fully twice as long as postocellar line; face very finely, densely punctate, opaque; head otherwise polished; thorax and propodeum polished; hind tibia distinctly longer than tarsus, latter with basitarsus about half the entire length, last joint slightly shorter than third.

Black, with the following markings: Quadrate spot on middle of face, outer corners of clypeus, small marks on inner orbits reddish; scape, pedicel, prothorax except posterior margins of notum and apex of pleurum, origins of notauli, scutellum, post-scutellum, tegulæ, spot below each wing, upper portion of metapleurum behind hind wing, hind margin of mesopleurum, posterior face of propodeum, including hinder apophyses, apices of anterior apophyses, a spot astride the pleural carina, front and middle coxæ largely and apical half of hind coxa, apices of basal

trochanter joints, apices of all femora and more or less of the lower side, front and middle tibiæ above, petiole dorsally before spiracles, apices of first and second tergites broadly and of others narrowly, and second sternite white to yellowish white; legs, except as noted, piceous to black; flagellum black above, brown below; mandibles piceous; wings brownish stained, the stain deeper beyond stigma along anterior margin, venation blackish, metacarpus pale.

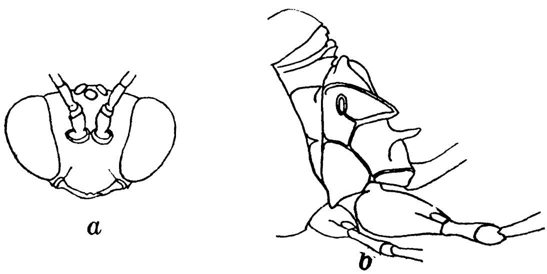

FIG. 8. *Apophysius bakeri* sp. nov.; *a*, head, front view; *b*, propodeum, lateral view; *c*, propodeum, dorsal view.

Male.—Practically identical with the female.

Type locality.—Mount Maquiling, Luzon, Philippine Islands.

Type.—Catalogue No. 24059, United States National Museum. One female and two males received from C. F. Baker.

ICHNEUMONINÆ

Ephialtes porthetriae (Viereck).

Pimpla (*Pimpla*) *porthetriae* Viereck, Proc. U. S. Nat. Mus. 40 (1911) 480.

Ephialtes formosana sp. nov.

In Morley's key to *Pimpla*[11] this new species runs to *P. appolyon* Morley, agreeing with all of the key characters and differing from the description on page 165 only in having the frons vaguely sculptured and medially canaliculate; palpi entirely flavous; tegulæ, mesothoracic spiracular sclerite, and a spot on scutellum white; propodeal spiracles very long, slitlike; all tergites narrowly white at apex; fifth tergite basally nearly as strongly punctate as fourth, others alutaceous, progressively more shining; front coxæ entirely, middle coxæ largely, and both trochanters white; stigma black, extreme base and metacarpus pale; areolet briefly petiolate, oblique.

[11] Fauna Brit. India, Hym. 3 (1913) 152.

It is also closely related to the Japanese *Ephialtes porthetriae* (Viereck), but that species, described only in the male, has the hind legs entirely (except extreme base of femur and apex of trochanter) and the front and middle coxæ and trochanters black, and differs also in structure and sculpture.

Female.—Length, 19 millimeters; antennæ, 15; ovipositor, 4.5. Temples very strongly receding; frons deeply concave, medially canaliculate, obsoletely punctate; face broader at clypeal foveæ than at antennæ, densely punctate, obliquely striately so above, less densely so at sides, with a median polished ridge, swollen above clypeal foveæ; clypeus coarsely punctate at base, polished and impressed in its apical two-thirds, apex subtruncate, the margin foveolate; malar space slightly more than half as long as basal width of mandible; eyes broadly emarginate opposite frons; ocelli large, diameter of a lateral ocellus nearly twice as long as ocellocular line and distinctly longer than postocellar line; antennæ slender filiform, first flagellar joint eight or more times as long as thick and a half longer than second; mesoscutum subpolished, obsoletely punctate, notauli practically wanting; scutellum flattened above, ridged laterally, polished; mesopleurum coarsely, subobsoletely punctate; metapleurum obliquely striate; propodeum transversely irregularly striate, polished behind, strongly ridged laterally, without carinæ, spiracle slit-like; abdomen very densely opaquely punctate; alutaceous at apex, each tergite with a narrow polished margin; first tergite without dorsal carinæ but with two low rounded elevations at summit; tergites 2 to 4 with decreasingly distinct subapical impressions and lateral elevations.

Black, with palpi, tegulæ, spiracular sclerite, spot on scutellum, front coxæ, middle coxæ at apex, and their trochanters whitish; front and middle legs otherwise stramineous, except base of middle coxa which is black; hind legs black with a broad whitish annulus on tibia; wings yellowish hyaline; abdomen with apices of tergites pale.

Host.—*Metanastria punctata* Walker.

Type locality.—Formosa.

Type.—Catalogue No. 24060, United States National Museum. One female reared from the host pupa by T. Shiraki.

Genus **LEPTOBATOPSIS** Ashmead

Because of the unretracted hypopygium Ashmead described this genus in the Acoentini. The genotype, *Leptobatopsis australiensis* Ashmead, is from Australia. Ashmead subsequently

redescribed it from the Philippine Islands, referring it to the lissonotine genus *Atropha* Kriechbaumer and calling it *Atropha clypearia*. *Atropha* is unknown to me except by description, but it is very closely allied to *Leptobatopsis* and possibly should include the latter genus as a synonym.

In 1913 [12] and again in 1915 [13] Morley referred several Indian species to *Syzeuctus* Foerster. One of these is *Cryptus indicus* Cameron, with which Morley synonymized *Mesoleptus annulipes* Cameron and *Tanera annulipes* Cameron. With Cameron's three descriptions *Leptobatopsis australiensis* agrees very closely, except with the sculpture of the thorax and the maculation of the mesoscutum in *Tanera annulipes*. Morley's synonymizing of the latter species with *C. indicus*, however, indicates that these differences do not exist, and I would certainly synonymize *L. australiensis* with *C. indicus* Cameron were it not for the fact that Morley states that the spiracle of the first tergite is slightly before the middle, while in *L. australiensis* it is distinctly though slightly behind the middle. Moreover, the first tergite is distinctly petiolate, which is not true of any of the species of *Syzeuctus* known to me. It may be that species intermediate in this character occur in the Indian fauna, but for the present it seems wise to retain Ashmead's name. The petiolate abdomen gives this species an appearance strongly resembling the Campoplegini, to which tribe I believe the Lissonotini are much more closely related than to the Ichneumonini (Pimplini).

Leptobatopsis australiensis Ashmead.

Leptobatopsis australiensis ASHMEAD, Proc. U. S. Nat. Mus. 23 (1900) 47; Proc. Linn. Soc. N. S. Wales, pt. 3 (1900) 349.
Atropha clypearia ASHMEAD, Proc. U. S. Nat. Mus. 28 (1904) 143.

Additional specimens from Singapore of this widely distributed species indicate that it probably occurs throughout the Oriental and Australian Regions. The principal variation aside from size is in the presence or absence of certain of the white spots on the head and thorax. The spots on the sides of the face, the one in the malar space, and those on the humeral angle of the pronotum and tegula are sometimes wanting, while the extent of white on the abdomen is variable, that on the apical tergites being sometimes absent.

Unless *Syzeuctus indicus* (Cameron) is the male of this species, that sex has not been described. It differs from the female

[12] Fauna Brit. India, Hym. 3 (1913) 234–240.
[13] Ann. & Mag. Nat. Hist. VIII 16 (1915) 337.

principally in having the clypeus entirely and the face largely white, the flagellum pale ferruginous beneath, and the fourth tergite, as well as the first to third, white at base and apex.

OPHIONINÆ

Zacharops narangae sp. nov.

The only way in which *Zacharops* as described by Viereck differs from *Charops* is in its lack of the mesosternal processes between the hind coxæ. The genotype also differs from that of *Charops* in having the scutellum concave between the lateral carinæ, the head thinner and more nearly lenticular, and the eyes more sharply emarginate. In all of these characters the present new species agrees with *Zacharops;* while it agrees better with *Charops* in the lack of complete propodeal areas and mesopleural impression and the form of the abdomen, especially of the first tergite, which is less slender with the postpetiole more bulbous than in *Zacharops annulipes* (Ashmead).

Female.—Length, 9 millimeters; antennæ, 6; front wing, 5. Head set very close to thorax, strongly lenticular, vertex and temples very strongly receding, opaque-punctate and, with the thorax, densely silvery pilose; face slightly narrower below than at antennæ; malar space half as long as basal width of mandible; ocellocular line more than half as long as diameter of lateral ocellus; thorax in both dorsal and lateral views short-ovoid, the propodeum very precipitous from base; pronotum rugose; mesoscutum very densely punctate, more coarsely so in the positions of the absent notauli; scutellum opaque-punctate, very densely pilose, slightly concave; mesopleurum reticulate-rugose, convex throughout, without impression; metapleurum divided longitudinally by an auxiliary carina, below which it is reticulate-punctate and above which it is transversely rugose; propodeum laterally transversely rugose, medially reticulate, the lateral and basal carinæ obsolete, others absent; abdomen slender; first tergite curved upward, postpetiole strongly bulbous, more than half as long as the slender petiole, without carinæ; second tergite slightly compressed for its entire length and with a small impression on each side at about the middle (this is common to the genotypes of both *Charops* and *Zacharops*); the spiracles slightly before apical fourth; tergites 3 to 5 subequal, little more than half as long as second, each deeper than the one preceding, sixth shorter and deeper than fifth, others very small; ovipositor barely exserted; entire abdomen beyond first tergite densely clothed with short, appressed pubescence.

Head and thorax black, abdomen largely ferruginous; scape and pedicel below, mandibles, palpi, front and middle legs, hind trochanters, tegulæ, and wing bases whitish; flagellum fuscous, more reddish toward tip; hind coxæ black basally, reddish at apex; hind femur testaceous, tibia stramineous with subbasal and apical infuscation, tarsus fuscous, calcaria white; wings hyaline, venation brown; petiole stramineous; second tergite medially and narrowly at apex blackish; a narrow line near lateral margins of second and third tergites also black.

Male.—Like female in size, sculpture, and structure, and differing practically only in having the abdomen black at apex.

Host.—*Naranga aenescens* Moore.

Type locality.—Formosa.

Type.—Catalogue No. 24061, United States National Museum.

A female and a male reared from the host larva by T. Shiraki. The cocoon from which the male emerged is on the pin. It is 6 by 2.5 millimeters, cylindric-ovate with a suspension thread at the caudal end. It is dirty white with the caudal end and a row of spots near each end black.

Hyposoter flavus sp. nov.

In spite of the indistinctly areolated propodeum and the very small, occasionally absent areolet, there is apparently no real reason for erecting a new genus for this species. In fact, the most striking difference to be noted is the nearly uniform pale yellow color of the head and thorax.

Female.—Length, 10 millimeters; antennæ, 7. Head from above very thin, the temples nearly flat and sharply sloping; face densely punctate, nearly flat; frons coriaceous, with a median carina from anterior ocellus to between antennal foramina; eyes large, concavely curved within; ocellocular line about half as long as diameter of a posterior ocellus, postocellar line slightly longer; malar space hardly half as long as basal width of mandible; thorax largely closely punctate; pronotum striate laterally; upper hind portion of mesopleurum polished, with a few short striæ in front of the polished area; mesopleural furrow foveolate; notauli weakly and broadly impressed anteriorly; scutellum strongly convex, sloping to apex; propodeum medially impressed, the carinæ usually distinct in the genus more or less indicated, especially the basal transverse and the apical abscissa of the lateral and pleural carinæ; spiracle elongate-oval, small; legs slender, longer hind calcarium reaching more than three-fourths of the way to apex of basitarsus; areolet very small with a very

long pedicel; nervulus postfurcal by nearly half its length; discocubitus curved, without a ramellus; nervellus nearly straight, unbroken, perpendicular; abdomen rather strongly compressed; spiracles of first tergite at apical third; ovipositor exserted about half the length of first tergite.

Flavous; a spot on vertex running down onto occiput and embracing ocelli, median, lateral, and posterior spots on mesoscutum, and a small spot on each side of propodeum at base blackish; flagellum blackish; legs flavous, hind tarsus and tibia at apices and articulation between hind femur and tibia blackish; wings hyaline; abdomen darker than thorax, especially toward apex.

Male.—Differs from female principally in having the malar space distinctly more than half as long as basal width of mandible and blackish spots on outside of hind coxa and trochanter.

Type locality.—Mount Limay, Luzon, Philippine Islands.

Other locality.—Manila, Philippine Islands.

Type.—Catalogue No. 24062, United States National Museum.

Two females and one male from the type locality collected by C. F. Baker, and one female from Manila collected by the Rev. Robert Brown. The Manila specimen lacks the black spots on the propodeum and the areolet in one wing, and is somewhat smaller.

ILLUSTRATIONS

PLATE 1

Apophysius bakeri sp. nov.; male. From a photograph by Herbert S. Barber.

TEXT FIGURES

FIG. 1. *Ctenocharidea luzonensis* sp. nov.; *a*, thorax and base of abdomen, lateral view; *b*, portion of thorax, propodeum, and base of abdomen, dorsal view; *c*, wings; *d*, claw of hind tarsus.

2. *Pycnopyge bella* sp. nov., female; *a*, entire insect; *b*, head, front view; *c*, thorax, lateral view; *d*, first abdominal segment, lateral view; *e*, apex of abdomen, lateral view.

3. *Nesostenodontus bakeri* sp. nov., female; *a*, dorsal view; *b*, head, lateral view; *c*, clypeus and mandibles; *d*, first tergite, lateral view.

4. *Idiognathus balteatus* sp. nov.; *a*, head, dorsal view; *b*, head, lateral view; *c*, clypeus and mandibles; *d*, propodeum; *e*, first abdominal segment, lateral view; *f*, first abdominal segment, dorsal view; *g*, second tergite, dorsal view.

5. *Elasmognathias albitarsis* sp. nov., head; *a*, ventrocephalic view; *b*, lateral view.

6. *Earrana malayensis* sp. nov.; *a*, dorsal view; *b*, head, front view; *c*, thorax, anterior portion, lateral view to show prescutum, *psct*, and epomia, *ep*.

7. *Esuchonematopodius luzonensis* sp. nov.; *a*, head, front view; *b*, venation in areolar region; *rad*, radius; *cub*, cubitus; *rec*, recurrent; *c*, thorax, lateral view.

8. *Apophysius bakeri* sp. nov.; *a*, head, front view; *b*, propodeum, lateral view; *c*, propodeum, dorsal view.

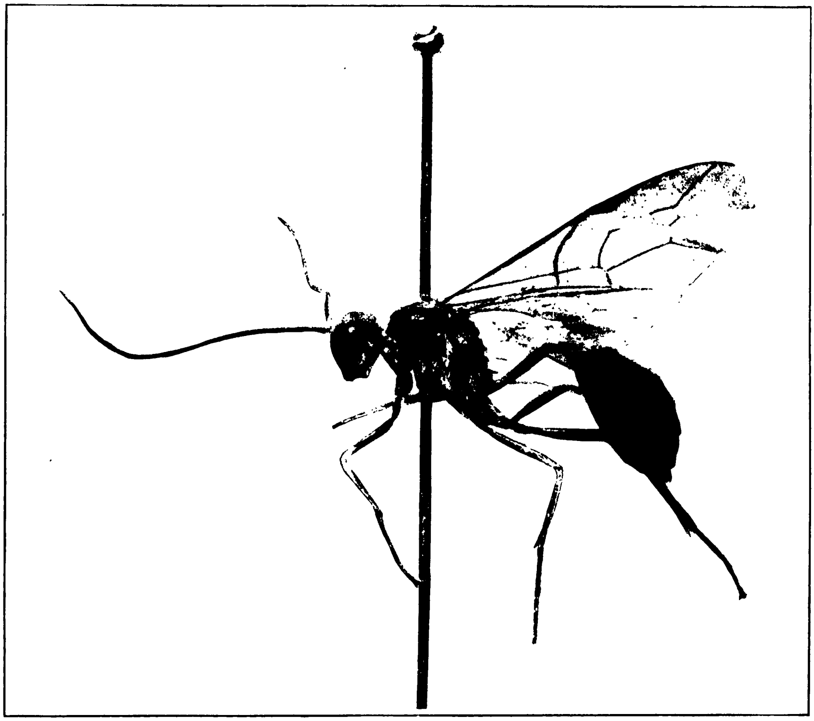

PLATE 1. APOPHYSIUS BAKERI SP. NOV., MALE.

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PHARMACODYNAMICS OF DATURA ALBA

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ONE PLATE

Datura alba Nees, or *talampunay*, is common throughout the Philippines. In and about Manila *Datura alba* Nees is the only species encountered. According to Merrill (9) it is not indigenous but of accidental introduction. The plant is widely distributed in tropical Asia, Africa, America, and Malaysia. In China and India it is employed as a medicine and as a poison. The Chinese frequently give the flowers mixed with food or in tea. Ford and Crow (6) and Mukopadya (10) reported several cases of *Datura* poisoning in China and India, respectively. In the Philippines, Bowman (2) reported a case of severe *Datura alba* poisoning in a chemist of the Bureau of Science. The chemist, while conducting experiments with *Datura alba*, ate approximately a gram of the seeds. One hour later, the following symptoms were observed: Dryness of the mouth, mydriasis, rapid pulse, flushed face, restlessness, laughing most of the time, scanning speech, and inability to form connected sentences. Later he became drowsy, fell asleep, and did not awaken until the next morning. On awakening, he seemed to be quite well, except for slight general weakness, mydriasis, and trouble in completing his sentences. Tavera's (13) description of the symptoms of *Datura* poisoning is practically identical. We have carried out the experiments detailed below in order to study the effects of the drug on animals, as well as its manner of action.

PREPARATIONS EMPLOYED

We employed alcoholic and aqueous preparations. The former was kindly given to us by Dr. P. Valenzuela, of the School of Pharmacy, University of the Philippines. It was prepared by him from the pulverized mature seeds of the plant, in accordance with the processes prescribed in the ninth decennial revision of the United States Pharmacopœia for the preparation of the fluidextract of belladonna, except that the last percolate was evaporated at 35° to 40° C. under low pressure. The latter was prepared as follows: Twenty mils of the alcoholic preparation were made alkaline by the addition of about 1 mil of 10 per cent ammonia, and then 30 mils of chloroform were added, and the mixture was shaken continuously for ten minutes. The mixture was allowed to stand in a separatory funnel, and the chloroform layer at the bottom, amounting to 32 mils, was removed. This was acidified by the addition of about 2 mils of dilute sulphuric acid and then 16 mils of water were added. This mixture was shaken continuously for ten minutes, allowed to stand in a separatory funnel, and the upper layer was taken off. The aqueous layer, after it was made neutral to litmus paper by the addition, drop by drop, of 10 per cent ammonia, amounted to approximately 21 mils. This aqueous solution was then allowed to evaporate in front of a rapidly revolving electric fan to 20 mils. The residue was slightly turbid and yellowish in color. The concentration of this aqueous preparation would be equal to the fluidextract if the active principles were completely extracted. We used this preparation in most of our experiments.

SYMPTOMS PRODUCED IN DOGS AND CATS

Hypodermic injection of 2 mils of the aqueous preparation per kilogram of weight of dog or cat chiefly affects the cerebrum, the respiration, the pupils, the pulse rate, and the secretion of tear and saliva. Within fifteen minutes after administration, the animal usually becomes restless and irritable when touched; the pupils dilate; the salivary secretion ceases; the respiration and the pulse are accelerated. The restlessness is followed by incoördination, then by sleep, and eventually by narcosis. The rate of the respiration is slowed as hypnosis sets in, but the mydriasis, dryness of the mouth and the conjunctiva, and rapid pulse persist even if the hypnosis lapses into narcosis. One of our protocols showing these different effects of *Datura alba* is given as Table 1.

TABLE 1.—*Symptoms produced by Datura alba in a male dog weighing 4.5 kilograms.*

[Date of experiment, January 25, 1921.]

Time.		Respiration per minute.	Pulse per minute.	Diameter of pupil.	Mucosa.			Remarks.
					Conjunctiva.	Lingual.	Nasal.	
a. m.	*p. m.*			*mm.*				
9.48		30	90	4	Moist	Moist	Moist	Quiet.
9.53		30	84	4	do	do	do	Do.
10.02								Two mils of aqueous preparation per kilogram injected hypodermically.
10.04		32	168	12	Moist	Moist	Moist	Cried whenever touched.
10.09		42	168	12	do	do	do	Slightly restless.
10.14		50	186	12	Dry	Dry	Dry	Restless.
10.29		54	192	12	do	do	do	Ataxic gait.
10.50		48	186	12	do	do	do	Barked frequently; sought dark place.
11.00		42	168	12	do	do	do	Quiet; lying down.
11.15		30	144	12	do	do	do	Drowsy.
11.35		30	138	12	do	do	do	Asleep.
	1.00	30	144	12	do	do	do	Stood with difficulty when made to do so; swayed to and fro and from side to side.
	2.00	26	138	12	do	do	do	Fast asleep.
	3.00	24	128	12	do	do	do	Do.
	3.30	24	128	12	do	do	do	Unable to walk.

ACTION ON THE CIRCULATION AND RESPIRATION

We studied under this heading the effect of *Datura alba* on the heart rate, the blood pressure, and the respiration. The blood pressure was recorded with a mercury manometer; the respiratory movement with Gunn's stetograph,(7) and the heart rate with a tambour connected with blood-pressure connection. Table 2 records the result of one experiment on a dog weighing 6.7 kilograms, which was anæsthetized with morphine and chloretone.

Table 2 shows that soon after intravenous injection of the aqueous *Datura alba* preparation the heart rate was increased

from 142 to 217 per minute. This gradually decreased, becoming nearly normal one hour after injection. The blood pressure rose slightly, while the pulse pressure was markedly diminished. As the heart rate was returning to normal the pulse pressure gradually increased, with a tendency to return to the normal condition. The respiration showed slight if any change in rate and depth.

TABLE 2.—*Effect of Datura alba on the circulatory and respiratory systems of a dog weighing 6.7 kilograms.*

Time.	Procedure.	Blood pressure.			Heart rate per minute.	Respiration.	
		Systolic.	Diastolic.	Pulse.		Rate per minute.	Amplitude as recorded in tracing.
p. m.		*mm. Hg.*	*mm. Hg.*	*mm. Hg.*			*mm.*
1.27		78	72	6	142	27	3.5
1.28	0.015 mil *Datura alba* preparation injected intravenously.						
1.29		79	78	1	217	27	3.5
1.30		79	78	1	218	27	3.5
1.40		82	81	1	199	26	3.5
1.50		84	82	2	176	28	4.0
2.00		87	84	3	168	26	4.5
2.15		88	84	4	166	27	3.5
2.35		90	85	5	163	27	3.5

ACTION ON THE PUPILLARY REFLEX

We used cats in studying the action of *Datura alba* on the pupillary reflex. The diameter of both pupils was measured in dim light. Table 3 shows a typical result of our experiment.

As shown in Table 3 the mydriasis becomes maximal in twenty-five minutes after the application of the preparation. The pupil remained maximally dilated for twenty-four hours. Then it gradually returned to normal, complete recovery occurring in from five to eight days after application.

We tried to localize the seat of action of the preparation in accordance with the method described in Sollmann's Laboratory Guide.(11) A dog was anæsthetized with morphine and chloretone. The short ciliary nerves were isolated, and the corresponding vago-sympathetic was exposed and cut. Stimulation of the central end of the vago-sympathetic nerve caused dilation of the pupil, while stimulation of the short ciliary nerves produced constriction. An injection of 5 centimils of

the aqueous preparation into the anterior chamber of the eye caused almost immediate dilatation of the pupil. Full dilatation was reached one minute after injection. Stimulation of the central end of the vago-sympathetic caused further dilatation, while even maximal stimulation of the isolated short ciliary nerves was ineffective. Stimulation of the iris through the edges of the cornea was also ineffective. However, we failed to elicit any effect in either the normal or the atropinized eye with this method of stimulation.

TABLE 3.—*Effect of Datura alba on the pupil of a cat.*

[Date of experiment, November 17, 1920.]

Time.	Procedure.	Diameter of pupil.			
		Right.		Left.	
		Horizontal.	Vertical.	Horizontal.	Vertical.
p. m.		*mm.*	*mm.*	*mm.*	*mm.*
1.25		3	5	3	5
1.30		3	5	3	5
1.35		3	5	3	5
1.37	1 drop aqueous preparation applied in right eye				
1.42		3	5	3	5
1.47		3	5	3	5
1.52		6	8	3	5
1.57		9	10	3	5
2.02		10	10	3	5
3.02		10	10	3	5
4.00		10	10	3	5

The immediate response of the pupil to local application of the drug indicates that its site of action is most probably peripheral. The action may be either on the dilator or on the constrictor mechanism. The dilator mechanism was probably not affected for it still responded to electric stimulation even after the administration of large doses. On the other hand, the constrictor mechanism was paralyzed, for it no longer responded to electric stimulation after application of the drug. The iris muscles consist of dilator and sphincter, and, since both are smooth muscles, it may be expected that if one is paralyzed by direct action of the drug the other will be similarly affected. Paralysis of the dilator muscle was not present for it still responded to vago-sympathetic stimulation; hence it may be deduced that the sphincter was not paralyzed. The action may be localized on the oculomotor nerve fibers, on the nerve

ending, or at the hypothetical myoneural junction.(5, 12) We applied the drug on the fiber of the short ciliary nerve, but we have not succeeded in limiting it there. However, since in general the nerve endings are more susceptible to the action of drugs than are the nerve fibers, it is highly probable that *Datura alba* caused mydriasis by paralyzing the ending or the myoneural junction of the oculomotor nerve.

ACTION ON THE SALIVARY GLANDS

We used dogs in our experiments on the salivary glands. The animals were anæsthetized with morphine and chloretone. One femoral vein was connected with an injection burette. The chorda tympani and the salivary gland of one side were isolated and protected from exposure. The flow of saliva was recorded by a drop-recorder. Table 4 is an abbreviated protocol of one of our experiments.

TABLE 4.—*Action of Datura alba on the submaxillary gland.*

[Date of experiment, January 12, 1921.]

Time.	Procedure.	Amount of secretion per minute.	Remarks.
p. m.		*Drops.*	
2.40	Stimulation of chorda tympani	6	Saliva ceased after a few drops.
2.42	Stimulation of gland	4	Do.
2.50	2 decimils of 1 per cent pilocarpine were injected to increase flow of saliva.		
3.02		3	Saliva dropped continuously and tended to increase.
3.08	4 centimils of the preparation injected	0	Saliva flow ceased 30 seconds after injection.
3.10	Stimulation of gland	⅓	1 drop per 3 minutes.
3.15	Stimulation of chorda tympani	0	
3.21	Stimulation of gland	½	1 drop per 2 minutes.
3.24	4 decimils of 1 per cent pilocarpine were injected	0	
3.27	5 decimils of 1 per cent pilocarpine were injected	⅓	1 drop per 3 minutes.
3.36	Stimulation of gland	½	1 drop per 2 minutes.
3.38		1	
3.40	Stimulation of gland	2	
3.45	Stimulation of chorda tympani	1	No change in the rate of flow.
3.48	5 decimils of 1 per cent pilocarpine were injected	2	
3.55	Stimulation of chorda tympani	4	

Table 4 shows that 4 centimils of aqueous preparation of *Datura alba* seed easily overcome the action of 2 decimils of

1 per cent pilocarpine on the submaxillary gland. This quantity of the preparation of *Datura alba* did not paralyze the submaxillary gland, but abolished completely the response of the chorda tympani to electric stimulation. The quantity of pilocarpine which completely antagonized 4 centimils of the aqueous preparation of *Datura alba* was between 11 and 16 decimils of 1 per cent pilocarpine.

The cessation of salivary secretion after the administration of *Datura alba* may be attributed to one of two causes; namely, to paralysis of the chorda tympani or to paralysis of the secreting cells themselves. Since *Datura alba* stops the secretion of saliva caused by pilocarpine which stimulates the end of the chorda tympani, and since the gland cells are not paralyzed, *Datura alba* must act by paralyzing the end of the chorda tympani. Therefore, its manner of action on the salivary glands is identical with that of atropine and its allies.

ACTION ON THE INHIBITORY FUNCTION OF THE VAGUS NERVES

The action of *Datura alba* on the inhibitory function of the vagus nerves was studied in dogs. The animals were anæsthetized with morphine and chloretone, and prepared for blood-pressure tracing and for intravenous injection through the femoral vein. Both vagus nerves were cut, and the peripheral ends were prepared for electric stimulation. The response to induced current of the vagus nerves under the influence of large and small doses of the aqueous preparation was observed. The vagus nerves were paralyzed in one minute after an intravenous injection of 8 centimils, or 1.6 centimils per kilogram of body weight, of the aqueous preparation of *Datura alba.* The paralysis of the right vagus in one of our animals was complete for about twelve minutes. Then it gradually disappeared and complete recovery occurred one hour and seven minutes after the administration of the drug. At that time the left vagus had only slightly recovered.

The inhibitory power of the vagus is weakened by small doses of *Datura alba.* In one of our experiments, the effect occurred soon after the injection of 0.0005 mil of the aqueous preparation per kilogram of body weight and persisted for about ten minutes. The vagus nerve recovered completely in fourteen minutes. When the dose was repeated, depression of the vagus occurred again, but complete recovery of the nerve was prolonged to twenty-five minutes. With twice this dose, depression

was very marked and recovery occurred only twenty-five minutes after the injection. The recovery of the vagus nerve from the second injection of this larger dose was delayed to forty-two minutes.

ACTION ON THE ISOLATED INTESTINE

The action of *Datura alba* on the intestinal movements was studied by suspending a 2-centimeter piece of small intestine of cat in 30 mils of Ringer-Locke's solution contained in a muscle warmer. The muscle warmer was placed in a water bath which was kept at 38° to 40° C. The Ringer-Locke's solution was supplied with bubbles of oxygen throughout the experiment. One end of the intestine was fixed at the bottom of the solution, while the other end was attached to a heart lever for tracing. A rise in tracing indicates a contraction of the intestine while a lowering indicates relaxation. Plate 1, fig. 1, shows the record of one of our experiments.

The effect on the intestinal movement was not constant. With fresh intestine, contracting rhythmically, addition of *Datura alba* to the Ringer-Locke's solution generally produced relaxation and cessation of contraction. If the intestine was left in the solution, spontaneous and usually regular intestinal contraction appeared. An additional amount of *Datura alba* at this time did not alter the contraction. If, soon after cessation of intestinal movement, the solution was changed and contraction again established, the addition of pilocarpine produced relatively slight stimulation. Intestinal movement produced by pilocarpine was overcome by *Datura alba*. It is assumed that the site of action of pilocarpine in the intestine is the vagus ends. To counteract this effect of pilocarpine, *Datura alba* must paralyze either the ends of the vagus nerves in the intestine or the intestinal muscle, or must stimulate the sympathetic inhibitory mechanism. The muscle was not paralyzed, for it could still contract on mechanical stimulation.

STRENGTH OF THE PREPARATION

To determine the strength of *Datura alba,* we compared its effect on the inhibitory function of the right vagus nerve with the effect of atropine, of hyoscine, and of hyoscyamine. The vagus was stimulated with a Harvard inductorium whose secondary coil was set, throughout the experiment, at 6-centimeter distance. The results we obtained in this experiment are shown in Plate 1, fig. 2. According to this experiment 0.0005 mil of

the aqueous preparation of *Datura alba* is approximately equivalent to 0.0025 milligram of either atropine or hyoscine in depressing the vagus. Hyoscyamine is slightly weaker than *Datura alba,* hyoscine, or atropine. In other words, 1 mil of the aqueous preparation of *Datura alba* seeds is equivalent to 5 milligrams of either atropine or hyoscine. Since the aqueous preparation and the fluidextract were found, by biological assay, to be equal in strength, and 1 mil of fluidextract represents 1 gram of the seeds, therefore 5 milligrams of atropine or hyoscine are equivalent to 1 gram of *Datura alba* seeds; or, in other words, the alkaloidal content of *Datura alba* seeds is 0.5 per cent. This result is almost similar to the alkaloidal content found by Bacon(1) and by Brill(3) in air-dried seeds of the Philippine *Datura alba,* using the chemical method.

Browne,(4) working with flowers of the Chinese *Datura alba,* obtained 0.485 per cent of total alkaloids which he regarded as all hyoscine. Hesse(8) found, however, with flowers provided by Browne, 0.55 per cent of total alkaloids of which approximately 92 per cent was hyoscine, 6 per cent hyoscyamine, and 2 per cent atropine. We have not ascertained whether or not the preparation we used contained mostly hyoscine.

THERAPEUTIC DOSES

The therapeutic doses of *Datura alba* seed may be estimated from the alkaloidal content obtained, or from the dose required to depress or to paralyze the vagus inhibitory nerves. In the former case, if the alkaloidal content is 0.5 per cent and the predominating alkaloid is either hyoscine or atropine, whose pharmacopœial doses are from 0.3 to 0.6 milligram, the corresponding therapeutic doses of *Datura alba* seed would be approximately from 0.06 to 0.12 gram, and of the fluidextract from 1 to 2 drops. As to the latter we found that 0.001 mil of the aqueous preparation or 0.001 gram of *Datura alba* seed, per kilogram of body weight, depresses or nearly paralyzes the vagus inhibitory nerves. For an adult, weighing 60 kilograms, the therapeutic dose would be 0.06 gram. In either case, therefore, the therapeutic doses obtained by calculation are similar.

SUMMARY AND CONCLUSIONS

1. The effects of toxic doses of *Datura alba* in dogs and cats correspond to those produced in man. In large doses it produces excitement, then incoördination, and, lastly, depression with tendency to sleep.

2. The respiration was increased in dogs and cats after large doses, probably through stimulation of the respiratory center.

3. It dilates the pupils by peripheral action. The most probable action in this case is paralysis of the oculomotor nerve ending or its myoneural junction.

4. It stops the secretion of the submaxillary gland produced by pilocarpine. Since the glands were not paralyzed, the site of action must be either the nerve ending or the myoneural junction which is stimulated by pilocarpine.

5. The endings of the vagus nerves are depressed by small doses and completely paralyzed by slightly larger doses. The increased heart rate, slight rise of blood pressure, and decreased pulse pressure can be explained by diminished tonus of the vagus nerves.

6. It tends to stop intestinal contraction by peripheral action, for this was obtained in isolated intestine.

7. The alkaloidal content of *Datura alba* seeds as assayed biologically, using atropine or hyoscine as standard, is 0.5 per cent.

8. The tentative therapeutic doses of *Datura alba* seeds that may be recommended for man are from 0.06 to 0.12 gram and of the fluidextract from 1 to 2 drops.

REFERENCES

1. BACON, R. F. Philip. Journ. Sci. **1** (1906) 1020.
2. BOWMAN, F. B. Bull. Manila Med. Soc. **3** (1911) 1.
3. BRILL, HARVEY C. Philip. Journ. Sci. § A **11** (1916) 257.
4. BROWNE, FRANK. Pharm. Journ. IV **3** (1896) 197.
5. CUSHNY, ARTHUR R. A Text book of Pharmacology and Therapeutics. Lea and Febiger, Philadelphia and New York, ed. 7 (1918) 341.
6. FORD, CHARLES, HO-KAI, and CROW, W. I. Pharm. Journ. III **18** (1887) 320.
7. GUNN, J. A. Journ. Physiol. **52** (1918) 29.
8. HESSE, O. Pharm. Journ. IV **10** (1900) 252.
9. MERRILL, ELMER D. Philip. Journ. Sci. § C **7** (1912) 166.
10. MUKOPADYA, G. M. Indian Med. Gaz. Calcutta **48** (1913) 312.
11. SOLLMANN, TORALD. A Laboratory Guide in Pharmacology. W. B. Saunders Co., Philadelphia and London (1917) 203.
12. SOLLMANN, TORALD. A Manual of Pharmacology. W. B. Saunders Co., Philadelphia and London (1918) 267.
13. TAVERA, T. H. PARDO DE. The Medicinal Plants of the Philippines. Translated and revised by J. B. Thomas. P. Blakiston's Son and Co., Philadelphia (1901) 179.

ILLUSTRATION

PLATE 1

FIG. 1. Normal contractions of isolated cat's intestine, augmented by the addition of 0.5 mil of 1 per cent pilocarpine, ceased after the addition of 0.05 mil of the aqueous preparation of *Datura alba*. The contractions returned soon after the solution was changed with fresh Ringer-Locke's solution. Additional amount of pilocarpine slightly increased the intestinal contractions.

2. Comparison of the effect of *Datura alba* on the vagus inhibition to the heart, with those of atropine and hyoscine. The use of 0.0025 milligram of atropine or hyoscine and 0.0005 mil of the aqueous preparation of *Datura alba* produced the same effect. B. P. indicates blood pressure; B. L., base line; S, stimulation of the right vagus nerve.

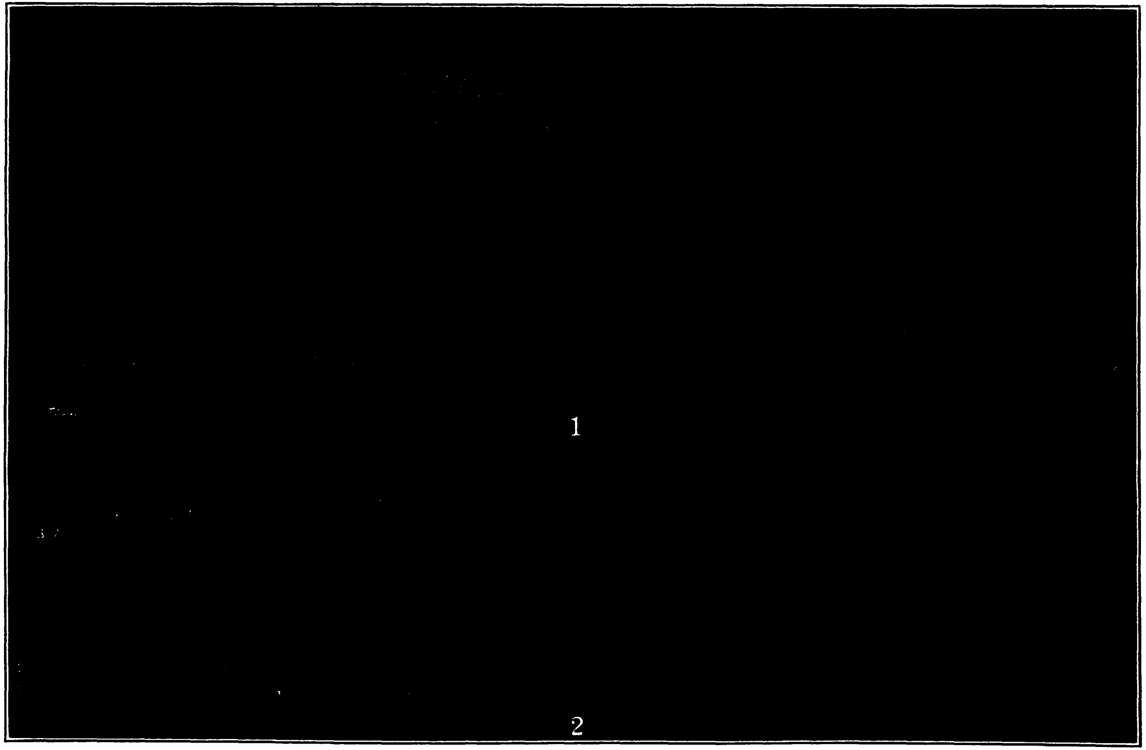

PLATE 1.

UNCOMMON INTESTINAL PARASITES OF MAN IN THE PHILIPPINE ISLANDS

REPORTS OF NEW CASES

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INTRODUCTION

Infestation of man with intestinal parasites is so prevalent in tropical countries that it is the absence rather than the presence of cysts and ova in stools that arouses attention. In the Philippien Islands the vast majority of the people, approximately 85 per cent, harbor one or more intestinal parasites. With few exceptions, the latter are species of protozoa and nematodes; in other words, parasites that are usually transmitted from host to host by means of polluted water, contaminated food, unclean hands, contact of the naked skin with soil infested with larvæ of parasites, etc. Intestinal parasites that are commonly encountered in Filipinos may be considered, therefore, an index to lack of sanitary conditions and to unhygienic habits.

In contrast to the almost universal occurrence in the Philippines of intestinal parasites in man that are conveyed from host to host directly through contact with cysts and ova is the rather uncommon occurrence of parasites that are conveyed from one person to another by intermediate hosts. Despite the surveys that have been made from time to time to determine the incidence of infestation of man in the Philippine Islands with intestinal parasites and the bearing of such parasitism on public health, comparatively few cases of infestation with flatworms have been recorded, and in nearly all instances the importance of cestode infestation in man and the possibility of transmitting these parasites to domestic animals with the

[1] Both authors assume responsibility for the new cases recorded in this paper; the senior author assumes full responsibility for the writing of the paper, for the review of the work of other investigators, and for the discussion of the significance of the several species of parasites that are considered in the paper.

resultant economic loss that such transmission involves have been almost entirely overlooked. As compared with protozoa and nematode infestations, flatworm infestations are so uncommon in the Philippines that physicians are apt to regard them as zoölogical curiosities rather than as problems worthy of serious consideration.

In the course of examinations of more than five hundred students of the University of the Philippines, between the ages of 20 and 30 years, representing nearly all provinces of the Philippine Islands, some flatworm infestations were discovered. In the following pages these cases are recorded, the published records of the same and closely related species of uncommon parasites are reviewed, and the significance of these cases of parasitism is discussed.

INFESTATION WITH TÆNIA

Three cases of infestation with *Tænia* were discovered in the course of the examinations referred to above. In one case gravid segments were obtained, which proved to be *Tænia saginata*. In the remaining two cases no segments were obtained, so that no specific determination could be made with certainty. In so far as measurements of ova are an index to specific identity, a diagnosis of *Tænia saginata* is warranted.

So far as concerns the frequency of *Tænia* in man in the Philippine Islands, Strong(13) records the results of about 1,800 stool examinations and 386 post-mortem examinations and states that only 2 adult *Tænia* were found. In the Annual Report of the Superintendent of Government Laboratories for the years 1902 to 1905(1) the results of 6,000 microscopic examinations of fæces are given and only 5 cases of cestode infections, namely *Tænia*, are recorded. Garrison(4) states that 26 of 28 specimens of *Tænia* from Filipinos proved to be *Tænia saginata*, the remaining 2 specimens being *Tænia solium*. The same author(5) records the results of over 4,000 stool examinations among which 30 cases of *Tænia* were found. Garrison and Llamas,(8) in a report on the results of examinations of 385 Filipino women and children for intestinal parasites, record 1 case of infestation with *Tænia*. Rissler and Gomez(12) report 8 cases of *Tænia saginata* infestation in 274 cases that were examined. In the same paper the authors refer to an unpublished case of *Tænia solium* in a Spaniard in Cagayan Valley. Chamberlain, Bloombergh, and Kilbourne(2) record 12 cases of *Tænia saginata* in 119 cases of examinations of Igorots

for intestinal parasites. They also refer to data collected in the Civil Hospital in Baguio, according to which 5 cases of infestation with *Tænia solium* and 4 cases of infestation with *Tænia saginata* were found in 183 examinations. Willets (16) records 59 cases of *Tænia* in over 4,000 fæcal examinations in tobacco haciendas in Cagayan Valley. Stitt (15) reports 3 cases of infestation with *Tænia saginata* in more than 900 examinations for intestinal parasites. Crowell and Hammack (3) report the results of 500 autopsies performed in the College of Medicine and Surgery in Manila and record but a single case of infestation with *Tænia saginata.* These authors state that but 1 case of *Tænia solium* was found in over 2,200 post-mortem examinations in the College of Medicine and Surgery. Crowell and Hammack refer to a case of *Cysticercus cellulosæ* in a Filipino, 28 years of age. This is apparently the first, and presumably the only, case of somatic tæniasis in man that has been recorded from the Philippine Islands. Willets (17) reports 1 case of *Tænia saginata.* The same writer (18) reports 57 cases of *Tænia* encountered in nearly 8,000 stool examinations, and Garcia (19) records 6 cases of *Tænia* in 1,600 stool examinations.

From the review of the literature with reference to infestation of man in the Philippines with *Tænia* it is evident that in the Philippines, as in other parts of the world, *Tænia saginata* is by far the commoner species and that *Tænia solium* is comparatively rare. In as much as the source of infection of human beings with *Tænia* is the flesh of cattle and hogs that is eaten without being cooked sufficiently to destroy tapeworm cysts, it follows that *Cysticercus bovis,* the larval stage of *Tænia saginata,* occurs in cattle and that *Cysticercus cellulosæ,* the larval stage of *Tænia solium,* occurs in hogs that are slaughtered in the Philippine Islands. As no data with regard to the extent of occurrence of cysticerci in cattle and hogs in the Philippines have been published, the senior author examined the files of the Bureau of Agriculture with a view of obtaining information on this point. The data presented in Table 1 were obtained through the courtesy of Dr. Stanton Youngberg, chief veterinarian of the Bureau of Agriculture.

Table 1 is based on the records obtained at the Azcarraga abattoir in Manila. The hogs in question are largely mestizos that are raised in the provinces under conditions that give them ready access to human fæces. Owing to the lack of privies in the provinces human fæces are generally devoured by hogs, thus favoring the perpetuation of *Tænia solium.*

TABLE 1.—*Showing the frequency of infestation of native hogs with Cysticercus cellulosæ.*

Year.	Hogs slaughtered.	Hogs infested.	Approximate infestation.
			Per cent.
1914	75,543	1,017	1.3
1915	84,736	1,275	1.5
1917	107,626	1,282	1.2
1918	108,145	1,275	1.1
1919	109,118	1,481	1.3
1920	109,662	1,123	1.0

From the data with reference to the occurrence of *Cysticercus cellulosæ* in native hogs, it will be seen that the degree of infestation with this parasite is comparatively high. In as much as pork infested with *Cysticercus cellulosæ* is regarded by public health authorities as unfit for human consumption, and since in countries where meat inspection is enforced carcasses infested with *Cysticercus cellulosæ* are generally condemned, unless the infestation is light, the economic loss sustained in the Philippines as a result of such infestation would be extremely high if meat-inspection laws were enforced throughout the Archipelago. It is greatly to be deplored that meat-inspection regulations for the safeguarding of human health are not enforced in the provinces of the Philippine Islands. While it is true that in the provinces more than 1 per cent of the hogs slaughtered are saved (?) from condemnation, it must be remembered that the provincial population is buying diseased meat that is not only objectionable from an æsthetic viewpoint but also dangerous to health. While Filipinos do not, as a rule, consume rare pork, the possibility of acquiring tapeworm infestation exists in the absence of enforcement of meat inspection. The fact that such infestations are actually acquired is evident from the undiminished source of infestation of hogs; namely, human fæces containing ova of *Tænia solium.*

Infection of man with *Tænia solium* is to be avoided not only because of the discomfort which it may cause and because of the possibility of passing the infection to hogs, due to the lack of privies, but also because *Cysticercus cellulosæ* is capable of developing in man and lodging in the brain, the eye, the muscular system, the heart, the subcutaneous connective tissue, the liver, the lungs, and other organs. One case of *Cysticercus cellulosæ*

infection in man has already been recorded in the Philippines, as noted elsewhere in this paper.

No data are available with regard to the occurrence of *Cysticercus bovis* in native cattle, because native cattle are seldom slaughtered in Manila abattoirs, and because in the provinces, where native cattle are killed for consumption, no meat-inspection service is maintained. Cattle slaughtered in Manila are usually imported from French Indo-China. These imported cattle are singularly free from *Cysticercus bovis*, as shown by the records of the Bureau of Agriculture for the years 1914 to 1920, exclusive of 1916, during which period only two cases of infestation with *Cysticercus bovis* were found in over 30,000 cattle examined post mortem for evidence of disease. According to Ransom(11) 1 per cent of all adult cattle slaughtered in the United States is infected with *Cysticercus bovis*.

INFESTATION WITH HYMENOLEPIS

One case of infestation with *Hymenolepis diminuta* was found in a male student, 20 years of age, from Samar Province; and, as will be shown presently, this is the first case of infestation with *Hymenolepis diminuta* in a Filipino that has ever been recorded. Cases of infestation with *Hymenolepis diminuta* in man are so rare the world over that reports of individual cases are warranted. A case from the United States and a review of all cases in that country recorded in the literature on parasitology have been recently published by Schwartz,(14) and several cases from the United States heretofore unpublished are to be found in that review.

Garrison(4) refers to a case of infection with *Hymenolepis diminuta* in a Chinese prisoner in Bilibid Prison, Manila. The same author(6) in a report on the prevalence of intestinal parasites in man in the Philippines, based on fæcal examinations of inmates of Bilibid Prison, refers to a case of infestation with *Hymenolepis diminuta* which is without question the same case as that recorded by Garrison in 1907(4) since the data published in 1908(5) are based on work performed in 1907 as stated by Garrison in the introduction to the former paper. The case of *Hymenolepis diminuta* that is recorded in this paper is, therefore, the first case of infestation with this parasite in a Filipino that has been recorded.

As is well known, *Hymenolepis diminuta* normally occurs in the small intestine of rats. Garrison(4) states that, in addition

to his material from the Chinese prisoner, the Bureau of Science collection contains two specimens of *Hymenolepis diminuta* from rats in Manila. One of us (Schwartz) has recently found many adult specimens of *Hymenolepis diminuta* in the intestines of house rats. About one dozen field rats have been examined thus far, and no adult tape worms have been found in them.

No case of infestation with *Hymenolepis nana* was found in the course of our examinations for evidence of parasitism. Garrison(4, 5) records 4 cases of infestation with this parasite. Rissler and Gomez(12) record 1 case of *Hymenolepis* infection, and Willets(16) records 5 cases; no specific determination is given in any of these papers. Willets(18) records 4 cases of *Hymenolepis* in nearly 8,000 stool examinations, and Garcia(19) reports 1 case in 1,600 examinations, but no specific determination is given by these writers.

INFESTATION WITH OTHER CESTODES

In addition to the species of cestodes that have been mentioned, Garrison(7) reports the presence of *Davainea madagascariensis* in an adult Filipino, the infestation having been discovered in the course of an autopsy. Mendoza-Guazon(10) records a case of *Dipylidium caninum* in a Filipino child, 8 months old, likewise discovered during an autopsy.

INFESTATION WITH TREMATODES

One case of *Clonorchis sinensis* infection was found in a Chinese student, 21 years of age. The Chinaman came from Canton, and had been living in the Islands several months when the infection was discovered. He showed no symptoms and did not complain, even after being questioned. A blood examination was made and the following results were obtained: Hæmoglobin, 90; total erythrocytes, 4,680,000; eosinophilia, 14 per cent.

Crowell and Hammack(3) in a report on intestinal parasites encountered in 500 autopsies record 2 cases of *Clonorchis sinensis* infestation in Chinese.

No additional records of *Clonorchis* infection in the Philippines have been found, and it may be concluded that this parasite has not yet been recorded from Filipinos. In view of the pathogenicity of this parasite, it is important that precautionary measures be taken to prevent the importation of *Clonorchis* infections to the Philippine Islands. It is uncertain, of course, that *Clonorchis* and other trematodes that occur in Chinese, Japanese, and other Orientals can be transmitted to new defini-

tive hosts in the Philippines because of the possible absence of intermediate hosts. In the absence of such knowledge precautionary measures are warranted, and Chinese, Japanese, and other immigrants arriving from countries where dangerous parasites of man are prevalent should be subjected to examination for parasites before being admitted to the Islands.

A case of infestation with *Echinostoma ilocanum* was found in a student, 22 years of age, a native of Zambales Province, Luzon. A second case of infestation with this parasite was found in a student, 23 years of age, from Ilocos Norte Province, northern Luzon.

This species, which has not been recorded outside of the Philippines, was first described by Garrison,(6) who found only 5 cases in about 5,000 fæcal examinations. All of Garrison's cases are individuals from northern Luzon. Willets(16) records a probable case of infestation with *Echinostoma ilocanum,* but makes no definite diagnosis. Hilario and Wharton(9) record 5 cases of infestation with this parasite, 4 of which are from Zambales Province; no data were given for the fifth case.

Nothing very definite is known concerning the possible pathogenicity of this parasite. Garrison's patients showed no symptoms and did not complain of feeling unwell. In the cases reported by Hilario and Wharton a slight anæmia was apparently present.

SUMMARY AND CONCLUSIONS

1. Three new cases of infestation with *Tænia* are recorded.
2. Data with reference to the occurrence of *Cysticercus cellulosæ* in native hogs show that from 1 to 1.5 per cent are infested.
3. A case of infestation with *Hymenolepis diminuta* is recorded. This is the first case in which this parasite has been reported from a Filipino and the second case that has been recorded from the Philippine Islands.
4. A case of *Clonorchis sinensis* is reported from a Chinese student. This is the third case that has been reported from the Philippines.
5. Two cases of infestation with *Echinostoma ilocanum,* a species apparently confined to Filipinos of northern Luzon, are reported.
6. To prevent infestation of man with *Tænia solium, Tænia saginata,* and *Cysticercus cellulosæ* and to eradicate infestation of hogs with *Cysticercus cellulosæ* and of cattle with *Cysticercus bovis,* as well as to safeguard the provincial population against

the consumption of diseased meats, extension of meat inspection to the provinces is recommended.

7. Routine examinations of immigrants arriving from ports where dangerous parasites of man are prevalent should be undertaken to prevent the introduction of such parasites into the Islands.

REFERENCES TO LITERATURE CITED

1. Annual Report of Superintendent of Government Laboratories, Report of the Biological Laboratory, Manila (1902) 569; (1903) 415; (1904) 445; (1905) 357.
2. CHAMBERLAIN, W. P., BLOOMBERGH, H. D., and KILBOURNE, E. D. Philip. Journ. Sci. § B **5** (1910) 505.
3. CROWELL, B. C., and HAMMACK, R. W. Ibid. **8** (1913) 157.
4. GARRISON, P. E. Ibid. **2** (1907) 537.
5. IDEM. Ibid. **3** (1908) 191.
6. IDEM. Ibid. **3** (1908) 385.
7. IDEM. Ibid. **6** (1911) 165.
8. GARRISON, P. E., and LLAMAS, R. T. Ibid. **4** (1909) 185.
9. HILARIO, J. S., and WHARTON, L. D. Ibid. **12** (1917) 203.
10. MENDOZA-GUAZON, M. P. Ibid. **9** (1916) 19.
11. RANSOM, B. H. Journ. Agr. Research **1** (1913) 15.
12. RISSLER, R. S., and GOMEZ, L. Philip. Journ. Sci. § B **5** (1910) 267.
13. STRONG, R. P. Circ. on Trop. Dis. Manila **1** (1901) 15.
14. SCHWARTZ, B. Journ. of Parasit. **7** (1921) 144.
15. STITT, E. R. Philip. Journ. Sci. § B **6** (1911) 211.
16. WILLETS, D. G. Ibid. **6** (1911) 77.
17. IDEM. Ibid. **8** (1913) 49.
18. IDEM. Ibid. **9** (1914) 233.
19. GARCIA, FAUSTINO. Ibid. **12** (1917) 25.

NEW PARASITIC HYMENOPTERA FROM THE ORIENTAL ISLANDS

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TWO TEXT FIGURES

This paper contains descriptions of new diapriids, bethylids, and braconids from the Philippine Islands, Borneo, and Singapore. The specimens studied in writing the descriptions were sent to the United States National Museum by Prof. C. F. Baker. Thanks are due and here recorded to Mr. S. A. Rohwer for permission to study Professor Baker's material, and to Miss Eleanor Armstrong for drawing the head of the new species *Loboscelidia maculipennis*. The other drawings were made by me.

DIAPRIIDÆ

Genus LOBOSCELIDIA Westwood

Westwood founded this genus on a single species, *L. rufescens* Westwood, from Sulu Island, southwest of Mindanao, Philippine Islands. Kieffer has described two new ones in his recent monograph of the family Diapriidæ.[1]

All the species, including those described in this paper, are from the islands southeast of Asia. *Loboscelidia defecta* Kieffer occurs both in Borneo and in Singapore if my identification is correct. Its type locality is Palawan Island of the Philippine group.

It seems probable that these wasps are myrmecophilous. They have somewhat the habitus of ants and the woolly appearance of the neck is characteristic of many myrmecophiles.

Key to the species of Loboscelidia Westwood.

Head in front with a hornlike projection............ **L. rufescens** Westwood.
Head in front without such a projection.. 1.
1. Basal nervure nearly absent, briefly indicated proximad.
L. bakeri sp. nov.
Basal nervure complete, distinct.. 2.

[1] Das Tierreich, Lief. 44 (1916) 14.

2. Body black; parapsidal grooves complete .... **L. nigra sp. nov.**
   Body rufous .... 3.
3. Face with a broad, circular, and shallow depression bordered by a sharp carina, the carina nearly touching the eye margin and the anterior ocellus .... **L. antennata sp. nov.**
   Face without an area inclosed by a carina .... 4.
4. Parapsidal grooves incomplete .... 5.
   Parapsidal grooves complete .... 8.
5. Basal nervure with a sharp bend at distal end. **L. philippinensis sp. nov.**
   Basal nervure not sharply bent at distal end .... 6.
6. Pronotum transverse .... 7.
   Pronotum a little longer than wide .... **L. inermis Kieffer.**
7. Face with an inconspicuous median furrow; wings conspicuously covered with brown spots and streaks .... **L. maculipennis sp. nov.**
   Face with a sharp median carina; each anterior wing with a yellowish band across its middle .... **L. carinata sp. nov.**
8. (4) Scutellum longitudinally striate or punctate .... 9.
   Scutellum polished, faintly shagreened or unsculptured .... 10.
9. Mesonotum shorter than the scutellum, its median lobe shagreened; membrane on hind tibia wider than the tibia itself.. **L. collaris sp. nov.**
   Mesonotum about as long as the scutellum, its median lobe polished. **L. scutellata sp. nov.**
10. Dorsal cervical plate highly arched, not concave...... **L. defecta Kieffer.**
    Dorsal cervical plate flattened, concave above .... **L. brunnea sp. nov.**

Loboscelidia bakeri sp. nov.

Male.—Length, 2 to 3 millimeters. Face flattened, smooth, finely shagreened, not carinate laterally, with a short median carina below, antennal ledge, seen from above, bilobed, emarginate medially, perpendicularly declivous in front, seen from the side without an inferior projection; dorsal cervical plate highly arched medially, quadrate, not excavated; cervical membrane just meeting, not overlapping, apparently without pubescence; antennæ as long as the body, slender, of an even thickness throughout; scape with a narrow membrane at base on the outside, a little longer than the three following joints united; joint 2 as long as wide, less than half as long as 3; joints 3 to 12 subequal in length and width, a little over twice as long as wide; joint 13 as long as 2 and 3 united, sharply pointed apically; pronotum about as wide as long, polished, feebly emarginate anteriorly, the posterior angles rather prominent; mesonotum broadly transverse, traversed longitudinally by two parallel parapsidal grooves and by two carinæ, one to each side, bisecting the lateral lobes; these carinæ not complete, obsolete anteriorly; median lobe longer than wide, faintly shagreened; scutellum more or less triangular, polished, its ante-

rior angles elevated, sharp; axillæ not indicated; membranous plates on legs narrow, inconspicuous; abdomen about as long as the thorax, wider, longer than wide; last segment sharply recurved, acute apically; wings large and long, mostly glabrous; maculations as in *L. inermis;* veins similar also but the basal nervure represented only by a stump proximad; radius five times as long as the anterior abscissa of subcosta, beyond the short stump of the basal nervure, nearly vertical; radius oblique, straight. Reddish brown, flecked with large black spots; sutures of thoracic sclerites blackish.

BORNEO, Sandakan (*Baker*), 4 males.

Type.—Catalogue No. 24315, United States National Museum. Paratype returned to Baker.

Loboscelidia nigra sp. nov.

Female.—Length, 3.60 millimeters. Face finely, obliquely aciculate, with a delicate median carina, and with a lateral carina extending from the malar space to the occiput, nearly touching the eyes medially; ocelli very large, nearly touching one another, the lateral ones less than their diameter from the back of the head; antennal ledge as in *L. bakeri* but more developed below, triangular seen from in front; face below antennæ obliquely striate; antennæ much longer than the body, slender, becoming narrower beyond the third joint; scape thick, broad, carinate, seen from the side three times as long as wide, a little longer than the next two joints united; joint 2 transverse, one-fourth the length of the third, which is a little less than three times as long as wide; joint 13 equal to 12, broadly rounded apically, nearly five times as long as wide; dorsal neckplate highly arched, distinctly longer than wide, with a shallow longitudinal depression; cervical membranes long, golden colored, striated, overlapping the shorter ones projecting from the anterior margin of the pronotum; pronotum transverse, slightly arched anteriorly and posteriorly, not emarginate in front, with two wide, shallow depressions behind; posterior angles of pronotum sharp but not prominent; mesonotum broadly transverse, polished, the posterior angles sharp, projecting over the axillæ; parapsidal grooves complete, parallel; median lobes very little longer than wide; scutellum broad, polished, sloping posteriorly, obliquely striate at the posterior angles; axillæ separated off from the scutellum by pitted sutures; propodeum perpendicular, polished; membranes on the legs inconspicuous, those on the hind legs wider; metatarsus of hind legs bent basally, as long

as the last three joints united; each tarsal claw with a sharp inner tooth; abdomen 6-segmented, as long as the thorax, the last segment punctulate, slightly recurved; wings glabrous, without cilia; basal nervure complete, oblique, the median cell wide; transverse medius as long as the subcosta beyond the basal vein, straight, oblique, not touching the submedius which is only half as long as the subcosta; postmarginal vein one-seventh the length of the radius, the latter straight, oblique, as long as the basal; forewings with a transverse brownish band in the region of the radius; otherwise the wings are hyaline. Black, touched in places with rufous; tegulæ reddish, very large, convex, reaching to the apex of the scutellum, truncated apically.

MINDANAO, Dapitan (*Baker*), type. BASILAN (*Baker*), paratype.

Type.—Catalogue No. 24316, United States National Museum.

Loboscelidia antennata sp. nov.

Female.—Length, 2.50 millimeters. Head broadly transverse, much narrower than the thorax, as high as wide; cheeks very wide, wider than the compound eye, sparsely covered with long, erect, white hairs, as is also the rest of the head including the eyes; ocelli large, very close together, the lateral ones less than their diameter apart, more than their diameter distant from the posterior margin of the head; ocelli situated in a large immargined depression; frons, including the bases of the antennæ, inclosed by a perfect circle formed by a sharp carina, this carina passing close to the eyes and to the anterior ocellus; inclosed area finely reticulated, subconcave; antennal ledge not prominent, perpendicular in front, truncate below; antennæ 13-jointed, short and stout, not as long as the body, sparsely pubescent; scape seen from above like a knife edge, thickened distally, curved, viewed laterally three times as long as wide, oblong, with a narrow hyaline membrane below, as long as the five following joints united; joint 2 a little longer than wide, narrower than 1, slightly wider and shorter than 3; joints 4 and 5 subequal, as long as wide, as wide as 3, cylindrical; joint 6 shorter, transverse; joint 7 shorter than 6, more widely transverse; eighth joint as long as the seventh, wider; joints 9 to 12 about twice as wide as long, narrower than the scape; joint 13 as long as wide, broadly rounded apically, punctate; dorsal cervical plate triangular, narrowed anteriorly, strongly arched above, pubescent, not concave; on the side of this sclerite there is attached a striated membrane of the appearance of

matted hairs, the parts of which curve outward and forward, projecting over a similar but smaller structure on the posterior part of the head; on the pronotum below and behind these head structures is a membrane of much the appearance of the others, the structure of which can be more easily observed; it may be that the matted or woolly appearance referred to above is caused by inner striation of the membrane; pronotum broadly transverse, slightly narrowed anteriorly, not emarginate, its posterior angles sharp; pronotum finely reticulate, with two broad shallow depressions posteriorly; mesonotum a little over half as long as the scutellum, with a broad depression on the outside of each parapsidal groove; median lobe shagreened; scutellum large, transverse, longitudinally carinate, posteriorly shagreened, with a polished median groove; axillæ separated off by deep grooves; postscutellum medially roughened, mostly unsculptured; membranes on tibiæ and tarsi very wide, as wide as or wider than the joints to which they are attached; abdomen as wide as the thorax, shorter; ovipositor projecting, two-thirds as long as the scape; wings glabrous, very large and long, with a brownish band variegated with hyaline across the middle; transverse median nervure shorter than the subcosta beyond the basal, straight, perpendicular; radius three and one-half times as long as the anterior abscissa of the subcosta, nearly straight, oblique, as long as the basal; basal vein curved distad; median cell wide, half as wide as the radius is long; submedius less than half as long as the subcosta.

STRAITS SETTLEMENTS, Singapore (*Baker*), 1 female.

Type.—Catalogue No. 24317, United States National Museum.

This species is most remarkable and could possibly be placed in a new genus. In its antennal structure it differs from all the other species of *Loboscelidia*.

Loboscelidia philippinensis sp. nov.

Female.—Length, 4 millimeters. Head higher than long, the cheeks not wider than the eyes, without pubescence or with only a few scattered hairs; frons flattened, finely shagreened, bordered laterally by a rounded ridge which extends from the antennal ledge to the occiput; ocelli large, disposed in a low triangle, the lateral ones their diameter apart and their diameter distant from the back of the head; ocelli not situated in a depression, the anterior one-half its diameter or less from the others; antennal ledge bilobed; wider than high seen from in front; dorsal cervical plate regularly arched above, polished,

subconcave, longer than wide, its sides parallel; cervical membranes prominent, not so large as in *L. antennata,* not overlapping, those on the head and neck the longest, evenly corrugated; antennæ slender, as long as the body, the flagellum not narrowing toward tip, all the joints except the first cylindrical; scape with a wide membrane, seen from the side three times as long as wide, not quite as long as the next three joints united; joint 2 as wide as long, half as wide as the scape, one-third as long as 3; following joints to the twelfth subequal to the third, becoming a little shorter toward the tip of the antennæ; joint 13 two and three-fourths times as long as wide, broadly rounded apically, longer than 12; pronotum polished, as wide as long, sightly widened behind, truncated anteriorly, more or less concave in the middle, with an arcuate depression on posterior third; mesonotum polished, more than twice as wide as long, as long as the scutellum, less than half as long as the pronotum; parapsidal grooves deep, incomplete, not present on posterior one-fourth; scutellum a little wider than long, mostly polished and flattened, on the side posteriorly indistinctly striate; axillæ not separated off from the scutellum; postscutellum with a median ridge, either side of which is roughened; abdomen as long as the thorax, not recurved below at tip, polished; wings hyaline, with a brownish band across the middle, a large spot on costal margin at apical third, and dark streaks marking the submarginal and discoidal veins; basal nervure straight to distal third where it makes a sharp bend and enters the subcosta nearly at right angles; transverse median nervure a little shorter than the anterior abscissa of the subcosta, straight; median cell less than half as wide as the radius is long; radius oblique, as long as the basal vein, five times as long as the oblique anterior abscissa of the subcosta; membranes on femora and tibiæ wide but not so wide as in *L. antennata;* metatarsus of hind legs five and one-half times as long as wide, not sharply bent basally, as long as the next three joints united, wider than either; second joint twice as long as wide, wider and longer than the third; third twice as long as wide, wider and longer than the fourth; joint 4 more than half as wide as long, joint 5 three and one-half times as long as wide, narrower than 4, longer than 2; claws sharp, each with a short acute inner tooth. Rufous; femora and tibiæ touched with yellow.

MINDANAO, Ilagan (*Baker*), 2 females (type and paratype); Kolambugan (*Baker*), 2 female paratypes.

Type.—Catalogue No. 24318, United States National Museum. Paratype returned to Baker.

Loboscelidia maculipennis sp. nov.

Female.—Length, 3 millimeters. Head longer than high seen from the side, the cheeks not wider than the eyes; face flattened, deeply excavated in the region of the antennal sockets, carinate laterally, the ridge running from the antennal ledge to the occiput; face striate and aciculate, with a short longitudinal suture in the middle; ocelli not situated in a depression, close together, the lateral ones their diameters apart and their diameters distant from the posterior margin of the head; cheeks

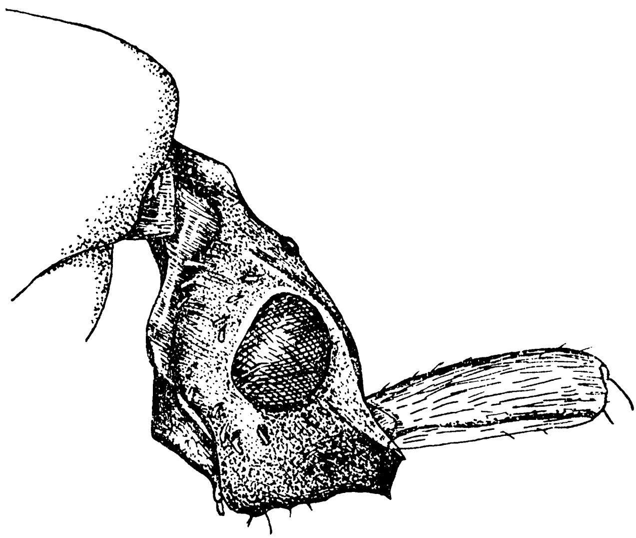

FIG. 1. *Loboscelidia maculipennis* sp. nov.; head, lateral view.

and malar space polished, sparsely covered with curious, short, club-shaped hairs of a silvery color; antennal ledge long, prominent, not thick, rounded in front; dorsal cervical plate flattened, quadrate, the membrane not conspicuous, extending down upon the cheeks, not touching the pronotal membrane which is ear-shaped, prominent; antennæ longer than the body, the joints beyond the scape cylindrical, equally wide; scape three times as long as wide, narrowed slightly proximad, with a narrow membrane beneath; pedicel as wide as long, one-third as long as joint 3, which is subequal to 12; in one antenna joint 10 is subconcave below and in the other antenna joint 10 is concave above (probably an abnormal condition); joint 13 three

times as long as wide, rounded apically; pronotum wider than long, polished, concave above, truncated anteriorly; pronotum sloping abruptly anteriorly; mesonotum polished, shaped as in *L. philippinensis,* as wide as the scutellum; parapsidal grooves incomplete, not indicated behind; scutellum transverse, polished, flattened, striate behind on the sides; axillæ partly separated off by deep grooves; postscutellum polished medially, not ridged; abdomen as in *philippinensis;* wings maculated as in *philippinensis;* basal nervure slightly bent at distal two-fifths; membranes on femora and tibiæ narow, inconspicuous; front tarsi as in *philippinensis.* Body entirely rufous, the thoracic sutures blackish.

BORNEO, Sandakan (*Baker*), 1 female.

Type.—Catalogue No. 24319, United States National Museum.

This species may be the same as *L. philippinensis* but seems to be distinct. Intermediate forms are unknown, and it seems best to separate what seem to be the extremes.

Loboscelidia carinata sp. nov.

Female.—Length, 3 millimeters. Differs from *L. maculipennis* in a few minor particulars: face more strongly striate and granulose medially, with a sharp median carina; basal nervure bow-shaped, not so distinctly angulate; anterior wing hyaline, with a yellowish band across its middle.

STRAITS SETTLEMENTS, Singapore (*Baker*), 1 female.

Type.—Catalogue No. 24320, United States National Museum.

Loboscelidia defecta Kieffer.

In the lot received from Professor Baker is a series of fifteen specimens representing this species. Two were collected at Singapore, and the rest at Sandakan, Borneo. They agree very well with the original description.[2] Sometimes the anterior abscissa of the subcosta is present, but very short. Kieffer's figure shows the maculation of the wings very nicely. In some of the specimens at hand the spots are indistinct and merge together, or they are pale and hard to trace.

Loboscelidia brunnea sp. nov.

Female.—Length, 3 millimeters. Closely related to *L. defecta* Kieffer from which it differs as follows: Frons polished, shining, not shagreened, with the lateral ridges higher and sharper, and with a sharp median ridge on lower half; dorsal cervical plate

[2] Das Tierreich, Lief. 44 (1916) 18.

wider than long, distinctly concave above, smooth and shining; pronotum more strongly arched in front, depressed behind the cervical plate, across the middle a little wider than long; axillæ more sharply set off from the scutellum by deep grooves; radial nervure distinctly shorter than the basal, oblique; anterior abscissa of subcosta present, much shorter than the radius.

BORNEO, Sandakan (*Baker*), 1 female.

Type.—Catalogue No. 24321, United States National Museum.

Loboscelidia collaris sp. nov.

Female.—Length, 2.2 millimeters. Head as long as high, mostly without pubescence; frons flattened, scarcely excavated below, finely and evenly shagreened, carinate laterally, with the carina becoming obsolete above, not distinct on the vertex; cheeks and malar space finely shagreened; lateral ocelli their diameter distant from each other and from the back of the head; antennal ledge short, bilobed as seen from above, with a lower projection, the whole structure of a triangular shape when observed from in front; above the clypeus is an acute median carina; antennæ longer than the body, slender, the joints beyond the first subequal in width; scape compressed, slightly narrowed basally, seen laterally three times as long as wide, as long as the next three joints united; joint 2 as wide as long, nearly half as long as 3; joints 3 to 12 subequal in length and width; joint 13 longer, almost as long as 2 and 3 united, subacute apically; dorsal cervical plate longer than wide, slightly narrowed anteriorly, strongly arched above; space between the head and thorax filled by the golden lobes of the woolly substance noted in my description of *L. antennata;* the membranes overlap one another and the result is a billowy appearance; pronotum wider than long, truncate anteriorly, flattened posteriorly, more or less arched in front, with two broad, shallow depressions behind the middle; mesonotum three times as wide as long, shorter than the scutellum, the median lobe shagreened, the lateral ones sharply carinate on the outside, each with a submarginal depression; parapsidal grooves complete; scutellum flattened, longitudinally striate; axillæ separated off by deep furrows; postscutellum with a low ridge medially, polished; abdomen as in *L. defecta;* wings hyaline, with a brownish band across the middle of each, and with a pale brown spot behind the band along the costal margin; basal nervure slightly curved distally, as long as the radius, four times as long as the anterior abscissa of the subcosta; nervulus shorter than the

subcosta beyond the basal, a trifle shorter than the anterior abscissa; submedian very short, much less than half as long as the subcosta; hyaline plates on femora and tibiæ very wide, on hind legs wider than the joints to which they are attached; metatarsus of hind legs four times as long as wide, slightly bent near the base, distinctly shorter than the three following joints united; joint 5 as long as 3 and 4 united, nearly four times as long as wide. Rufous; margin of the pronotum and the tegulæ in part blackish.

STRAITS SETTLEMENTS, Singapore (*Baker*), 1 female.

Type.—Catalogue No. 24322, United States National Museum.

Loboscelidia scutellata sp. nov.

Female.—Length, 3 millimeters. Differs from *L. collaris* as follows: Head higher than long, covered with long silvery hairs below; cheeks polished, as wide as the eyes; face strongly shagreened, with a median carina below; carinæ on the sides of the face sharp, extending to the occiput; ocelli very close together, the lateral ones less than their diameter from each other and from the posterior margin of the head; scape less than three times as long as wide, a little shorter than joints 3 and 4 united; joint 2 as wide as long; joint 3 as wide as 2 and any of the joints following it, two and one-half times as long as the second joint; following joints becoming gradually longer and narrower, the middle ones slightly curved; joint 13 as long as 2 and 3 united, five times as long as wide, subacute at tip; dorsal cervical plate scarcely narrowed anteriorly, longer than wide, with a shallow median depression; pronotum a little wider across the middle than long, somewhat wider posteriorly, polished; mesonotum shining, two and one-half times as wide as long, as long as the scutellum; parapsidal grooves complete, the median lobe subconcave; scutellum finely longitudinally striate; axillæ separated off by deep grooves; postscutellum slightly elevated medially, polished; wings subhyaline, darker around the radius; nervulus longer than the anterior abscissa of the subcosta, straight; basal nervure nearly straight, slightly curved distad, as long as the radius; anterior abscissa of subcosta longer, about half as long as the subcosta before the latter forks, straight; plates on femora and tibiæ narrow, not wider than the joints to which they are attached; metatarsus a little over four times as long as wide, nearly as long as the next three joints united. Coloration as in *L. collaris* sp. nov.

BASILAN (*Baker*), type. MINDANAO, Surigao (*Baker*), 1 paratype. Five specimens received.

Type.—Catalogue No. 24323, United States National Museum. Paratype returned to Baker.

BETHYLIDÆ

Lestodryinus stantoni Ashmead.

Dryinus stantoni ASHMEAD, Proc. U. S. Nat. Mus. **28** (1904) 134 (♀).
Prodryinus stantoni (Ashmead) KIEFFER, André, Spec. Hym. Eur. **9**: 498; Das Tierreich, Lief. **41** (1914) 53.

Runs in Kieffer's key [3] to *L. perkinsi* Kieffer and differs from that species as follows: Frons with many variously curved longitudinal carinæ, and with a high and sharp median ridge below the anterior ocellus, clothed with short silvery hairs; clypeus wider than long, wide anteriorly, the two teeth rounded and far apart; mandibles blackish medially, brown basally, and with rufous teeth; first and second antennal joints yellowish brown; 3 to 9 black; joint 9 one and one-half times as long as wide; joint 10 yellow, longer than 9, slightly narrowed distally; mesonotum two-thirds as long as the pronotum, measuring the latter from its anterior border to the apices of the lateral lobes, finely granular, somewhat more coarsely so posteriorly, densely covered with short silvery hairs; postscutellum granular, half as long as the scutellum; upper face of propodeum bordered posteriorly by a low ridge and with another ridge immediately in front of the other; distal part of radius hardly longer than the proximal part; postmarginal short, not well pigmented, much shorter than the parastigma; legs rufous, variegated considerably with blackish; middle and posterior tibiæ, metatarsus, and last tarsal joint piceous; other tarsal joints reddish; front femora gradually narrowed distally, thick basally, brown; front coxæ hardly over half as long as the femora, brown with yellow markings; lateral claw of chela with a row of nine widely separated white spines, the distal tooth minute, hard to see; last segment of abdomen thickly covered with short white hairs on apical half; abdomen mostly black, the last segment yellowish brown.

Length, 4.5 millimeters.

LUZON, Manila.

[3] Das Tierreich, Lief. **41** (1914) 20.

Type.—Catalogue No. 8000, United States National Museum. Redescribed from the type specimen in the United States National Museum.

Lestodryinus kiefferi sp. nov.

Female.—Length, 6.5 millimeters. Head a little over two-thirds as long as wide, flat above, its posterior margin acute, straight; head strongly excavated below the upper posterior margin, attached to the thorax at its ventral surface, wrinkled and with a rather deep longitudinal furrow below; frons shagreened, with many wavy longitudinal wrinkles, and with a median carina; hind margin of eyes projecting beyond the head posteriorly; median carina not reaching the clypeus; clypeus granular, wider than long, bidentate at apex, the emargination arcuate; malar space two-thirds the length of the clypeus, longitudinally striate; mandibles 4-dentate, the lower tooth the longest; maxillary palpi 5-jointed, brown; fifth joint hardly longer than the fourth, yellow, blunt apically; labial palpi 3-jointed, brown; first joint three times as long as wide, devoid of pubescence, as long as the second; second joint scarcely longer than wide, flattened, densely covered with long white hairs; third joint much longer, threadlike, nearly as long as the first two united, finely pubescent; scape more than twice as long as the pedicel; scape and pedicel united not quite three-fifths the length of joint 3; joint 3 scarcely widened apically, less than twice as long as 4; joints 8 to 10 yellow; 10 longer than 9, as long as 7, blunt apically; pronotum mostly granular, finely pubescent, somewhat elevated posteriorly, without a transverse incision anteriorly; mesonotum rugose, inconspicuously pubescent, the parapsidal grooves complete but shallow and nearly lost in the rough sculpture; scutellum rugose, with a deep narrow depression across its base, the depression divided medially by a narrow partition; propodeum irregularly reticulate, a condition similar to that found in *Psilodryinus reticulatus* sp. nov.; propodeum rounded apically, somewhat excavated behind, the excavation bordered on each side by a longitudinal ridge; abdomen as long as the thorax, somewhat flattened; the last two segments compressed, the seventh more strongly so than the sixth; segments 1 to 5 finely granular, opaque, sparsely pubescent; 6 shining, with a few large scattering punctures; segment 7 triangular seen from the side, rounded apically, like a knife edge seen from above, finely and closely pubescent and punctate; seventh tergite very small, triangular, with a row of

long black hairs on each side posteriorly; ovipositor projecting the length of the sixth tergite, yellow, the sheaths brown; wings hyaline, with two brown transverse bands, the inner one narrow and inconspicuous, the outer one broad and well defined; radius not half complete, well pigmented, not much longer than the basal; nervulus interstitial with the basal, narrowly interrupted before it reaches the medius; legs long; front coxa as long as the metatarsus, not so thick as the femur; trochanter narrower than the coxa, two-thirds as long; femur as long as the coxa and trochanter united; a trifle longer than the tibia; metatarsus longer than all the following joints united; joint 4 flattened, longer than 2 and 3 united; inner claw of chela about as long as joints 2 to 4 united, furnished inside with a double row of short throns; outer claw slightly curved, with a row of thorns inside claws on middle and hind legs with an inner tooth basally. Black; mandibles, antennal socket, last three antennal joints, chela, metatarsus of anterior legs apically, and the other tarsal joints entirely, last segment of abdomen, rufous for the most part.

LUZON, Mount Maquiling (*Baker*).

Type.—Catalogue No. 24324, United States National Museum.

This species, known from a single specimen, differs from *L. luzonicus* Kieffer in the color of the antennæ and in having the radius shorter. Other differences occur and may be recognized by comparing my description with Kieffer's.[4]

Psilodryinus thoracicus sp. nov.

Female.—Length, 5 millimeters. Very closely related to *P. sumatranus* of Enderlein, from which it differs as follows:

Distance of lateral ocelli from each other more than half their distance from the anterior one; posterior margin of pronotum not emarginate, the lateral lobes not in evidence; elevation on posterior lobe of pronotum with many transverse carinæ anteriorly; wings colored with a light brown; first abscissa of cubitus, discoideus, first recurrent, and subdiscoideus visible as white lines in the semiopaque transverse wing band; basal vein well pigmented to distal third; cubitus and subdiscoideus visible as brownish lines distad of the whitish transverse band, not reaching the wing margin; legs dull reddish except as follows: Anterior trochanters, tibiæ basally, most of femora, posterior metatarsus except at apex, middle and hind tibiæ,

[4] Das Tierreich, Lief. 41 (1914) 24.

metatarsi, and last joint of tarsi dark brown or fuscous; fourth joint of posterior tarsi considerably longer than 2 and 3 united, two-thirds as long as the first; lateral claw yellow, unarmed except for a short tooth subapically; head and thorax closely covered with short silvery hairs.

PALAWAN, Puerto Princesa (*Baker*), 1 female.

Type.—Catalogue No. 24325, United States National Museum.

Psilodryinus reticulatus sp. nov.

Female.—Length, 6.5 millimeters. General structure as in *P. thoracicus* sp. nov.; face with many parallel longitudinal ridges which extend back on the occiput, with a median carina; interocellar space traversed by several of the facial carinæ; clypeus rounded apically, shagreened; labial palpi 3-jointed, short; joint 1 twice as long as wide, as wide as 2 but a little longer, not quite as long as 3; 3 blunt at apex, much narrower than 1 or 2, threadlike; maxillary palpi 5-jointed; first joint twice as long as wide, half as long as 2, as wide as 2 distally; joint 2 widened apically, a little shorter than 3 but much wider; joint 3 as wide as 4 or 5, as long as 5, a little longer than 4; joint 5 pointed apically, threadlike; scape twice as long as the pedicel; pedicel over twice as long as wide, wider than joint 3; joint 3 very long, over two and one-half times as long as the scape, very slender, widening distally; joint 4 nearly two-thirds as long as 3, a little longer than 5; joint 6 half as long as 4, four times as long as wide, following joints except the tenth becoming gradually shorter; joint 10 as long as 7, blunt apically; pronotum closely punctulate, very little longer than wide, somewhat narrower than the thorax, highly elevated behind the horseshoe-shaped incision, the elevation anteriorly with a few sharp transverse carinæ; mesonotum with two diverging carinæ in the position usually occupied by the parapsidal grooves, with a median carina; inclosed areas finely punctate, covered with short white hairs; scutellum with four foveæ basally, the lateral ones the largest, with longitudinal and transverse carinæ intersecting; propodeum evenly convex, covered with small polygonal areas bordered by curved raised lines, without pubescence; legs black except the lateral claw of the chela; front coxæ long, reaching a little behind the posterior margin of the prosternum, densely pubescent beneath; front trochanters long, curved medially, thickened distally, half as long as the femora; femora a little longer than the tibia, thicker, narrowed distally; tibiæ gradually narrowed proximally; posterior metatarsus not

quite half as long as the tibia, equaling in length the distance from the base of the fourth joint to the apex of the fifth; fourth joint much longer than the second and third united, widened distad; median claw of chela as long as joints 1 to 4 united, with a row of short white plates below; lateral claw yellow, bare, curved behind the middle, narrow, as long as joints 1 and 2 united, with a short tooth before the apex; legs entirely covered with a short white pubescence; tarsal claws sharp, without teeth; wings as in *P. thoracicus*, but with a narrow transverse band in the region of the radius and with the radius a little shorter; it can be clearly seen that the darker color of the wings is due to the presence of pigment in the hairs; abdomen rather long, sharply pointed and narrowed toward apex, polished, sparsely covered with short white hairs; first segment bell-shaped, of the form found in the wasps of the subgenus *Odynerus;* sixth segment shorter than the fifth, longer below than above; ovipositor projecting the length of the last tergite. Body black; antennæ at tip and abdomen at base and apex touched with rufous.

LUZON, Los Baños (*Baker*), 2 females.

Type.—Catalogue No. 24326, United States National Museum.

One specimen has the ovipositor more in evidence. The abdominal segments are telescopic and so the relative proportions vary considerably.

Genus **NEOANTEON** novum

Head transverse, wider than the thorax, margined and slightly arcuate posteriorly; face convex; cheeks rather wide, narrower than the eyes; eyes large, bare, converging slightly anteriorly; ocelli present, arranged in a small triangle; clypeus transverse; mandibles 4-dentate, the second and fourth teeth the largest; upper tooth a little longer than the third; maxillary palpi 5-jointed; antennæ 10-jointed, joints 3 to 9 of somewhat similar shape and size; thorax short, wider than high, scarcely longer than wide; mesonotum transverse, longer than the pronotum, with the parapsidal grooves briefly indicated anteriorly, far apart; pronotum inconspicuous seen from above, somewhat constricted medially; scutellum transverse, unarmed, with a narrow and deep fovea across its base; propodeum areolated, with ten inclosed spaces, declivous, with a broad vertical impression laterally; abdomen small, with a long petiole, constricted below between the petiole and the second sternite; wings normally developed, maculate; venation generally as in *Anteon*

Jurine; radius with proximal abscissa straight, a trifle longer than the distal abscissa which is slightly curved, almost reaching the wing margin; submedian cell nearly as long as the median, the nervulus oblique; brachius short, well pigmented basally; basal vein shorter than the first abscissa of the radius, abruptly angulate before it attains the subcosta; prostigma absent, parastigma half-elliptical, shorter than the basal nervure; hind wings without a cell; legs moderately long; metatarsus of hind legs longer than the fourth joint which is longer than 2 and 3 united; claws of chela strongly curved, short, the inner one with a broad blunt tooth medially, and the outer one with a rather long sharp tooth below at distal third; otherwise the claws are unarmed; claws of middle and hind legs sharp, without dentition.

This genus comes closest to *Anteon.* It differs principally in its pedicellated abdomen and in the peculiar structure of the chelæ which are devoid of bristles and lamellæ. The venation also offers minor differences.

The genotype is from the Philippine Islands and may be known under the name:

Neoanteon rubrica sp. nov.

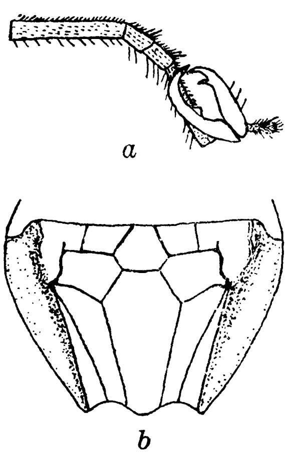

FIG. 2. *Neoanteon rubrica* sp. nov.; *a*, anterior tarsus, lateral view; *b*, propodeum, dorsal view.

Female.—Length, 3 millimeters. Entire body shining, without strong sculpture, finely and sparsely pubescent; face with scattered punctures, with a median carina extending from the anterior ocellus to the clypeus; subconvex, rounded anteriorly; scape short, nearly as long as joints 3 and 4 united; joint 2 a little shorter than 3; joints 3 to 6 subequal, a little longer but no wider than joints 7 to 9; joint 10 longer, broadly rounded apically; mesonotum with a few scattered punctures; propodeum areolated as shown in fig. 2; abdomen as long as the head and thorax united, depressed, mostly without pubescence; petiole slender, seven times as long as wide, as long as the propodeum; second tergite scalelike, longer than the petiole, broadly rounded apically, its sides extending around the base of the petiole in a wide subhyaline plate; third segment as long as all the follow-

ing united, shorter than the second; segment 4 longer than 5; segment 6 compressed, a little longer than the fourth; anterior coxa as long as the pronotum, densely pubescent below; femur longer than the coxa and trochanter united, wider than the coxa; tibia as long as the first three tarsal joints united, its distal spur blunt, finely pubescent; metatarsus twice as long as the next two joints united, about six times as long as wide; joints 2 and 3 equal, as long as wide; empodium half as long as the fourth joint; wings smoky, with three transverse brown bands, one through the basal, one through the radius, and the other near the apex. Rufous; scape, pedicel, base of third joint, joints 7, 8, and 9, clypeus, mandibles except the teeth, and all the legs straw-colored; antennal joints, other than those mentioned above, dark brown.

LUZON, Los Baños (*Baker*), 2 females.

Type.—Catalogue No. 24327, United States National Museum.

BRACONIDÆ

Helorimorpha fumipennis sp. nov.

Female.—Length, 4.5 millimeters. Head as wide as the thorax, twice as wide as long, strongly punctate, a white hair issuing from each puncture; middle of face somewhat less strongly punctate; clypeus broadly transverse, slightly and broadly emarginate apically, flattened, finely punctate; mandibles long, the upper tooth longer than the lower, very sharply pointed; antennæ originating above the middle of the face, as long as the body, all the joints subequal in width, cylindrical; scape punctate, more than twice as long as wide; joint 2 a little longer than wide; 3 narrowed basally, as long as the scape; following joints to the seventeenth becoming gradually shorter; joint 18 as long as 7, sharply pointed apically, two and one-half times as long as wide; face with a sharp keel between the antennæ; aperture inclosing antennal socket opening upward, circular; thorax short, two-thirds as wide as long, as high as wide, marked all over with large, shallow, five- or six-sided pits bordered with low rounded ridges; parapsidal grooves not indicated; propodeum quadrate, broadly and shallowly excavated on its posterior face; first abdominal segment six-sevenths as long as the thorax, slender, curved, gradually widened apically, much narrower than the hind coxæ; abdomen entirely polished, the segments beyond the first forming a solid piece, as long as the thorax; wings brownish, hyaline apically, basally (including the entire basal cell), and medially in a narrow band dividing

the first cubital cell and the second discoidal at base; veins brown; first transverse cubitus straight, as long as the second abscissa of the cubitus; first abscissa of the radius straight, as long as the second abscissa and second transverse cubitus united, the latter a little longer than the former; discoidal vein short beyond the second transverse cubitus, represented by a long brown streak distally; third abscissa of radius straight, reaching the postmarginal which extends slightly beyond their junction. Body shining black; legs yellowish brown to piceous, the coxæ and most of hind legs darker; antennæ yellowish brown basally, piceous toward the apex.

Male.—Length, 4.5 millimeters. Differs little from the female. Only by the slightly extruded genitalia can I determine one specimen as the male. The ovipositor may be seen in the type by the use of the highest power of the binocular microscope. It is nearly concealed beneath the overhanging edges of the apical sternites.

MINDANAO, Dapitan (*Baker*), 2 specimens.

Type.—Catalogue No. 24328, United States National Museum.

This species differs from *H. fisheri* and *H. brasiliensis* in having the body black, and from *H. egregia,* the genotype, in having the wings tinged with brown.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Loboscelidia maculipennis* sp. nov.; head, lateral view. (Drawing by Eleanor Armstrong.)

2. *Neoanteon rubrica* sp. nov.; *a*, anterior tarsus, lateral view; *b*, propodeum, dorsal view. (Drawing by R. M. Fouts.)

EFFECT OF DIFFERENT RATES OF TRANSPIRATION ON THE DRY WEIGHT AND ASH CONTENT OF THE TOBACCO PLANT[1]

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REVIEW OF PREVIOUS WORK

Authorities are divided in their views regarding the relationship between the rate of transpiration of a plant and the intake of soil solutes. On the one hand it is held that the amount of solute taken up by the plant from the soil solution is proportional to the amount of water transpired, while on the other the amount of solute taken in by the plant is believed to be independent of the amount of water transpired. The available experimental data relating to this question are few.

As early as 1849 Lawes,(1) while realizing the relationship of evaporation to rapidity of growth to be yet a problem, nevertheless assumed generally that the comparative rate of evaporation of water to some extent indicates the comparative activity of the processes of the plants. In his experiments with wheat, barley, beans, peas, and clover, in which he determined the amount of water given off by the plants and the amount of dry matter and ash obtained from them, he got a greater amount of dry matter and ash with a greater amount of water, and vice versa. It should be remarked, however, that the plants were not given the same soil treatments. He merely concluded that these experiments indicated some definite relationship between the passage of water through the plants and the fixation in them of some of their constituents.

Schloesing,(2) in 1869, grew one tobacco plant under a shaded bell jar and three in the open. The water evaporated per plant in the open averaged more than three times that evaporated

[1] A report on the research problem presented in 1917 to the department of botany, Cornell University, to satisfy in part the requirements for a minor in plant physiology.

under the bell jar. He found a greater percentage of total ash in the leaves of the plants grown in the open than in those of the one plant under the shaded jar. This experiment is of little or no value, as only the leaves were analyzed and only very few plants were grown. It is interesting to note, however, that he assumed the difference in the ash content to be due to the difference in total transpiration.

According to Hasselbring(10) Fittbogen expressed in 1871 an idea similar to that of Lawes.

Sorauer,(3, 4) in 1878–1880, grew various species of plants such as barley, pea, lupine, and others in humid and dry conditions and found in general a greater amount of dry substance and a higher percentage of ash under dry conditions than under humid.

Hasselbring(10) again tells us that in 1883 Hellriegel considered there was no relationship between transpiration and the production of dry matter, and that Kohl in 1886, on anatomical grounds, assumed that a rapidly transpiring plant receives, by means of the transpiration stream, far greater amounts of mineral nutrients than a plant with lower transpiration.

Wollny,(5) in 1898, grew barley, vetch, lucerne, and flax under dry, moist, and medium conditions. In general he found greater absolute amounts of fresh and dry substances and a higher percentage of ash under humid conditions than under dry atmosphere. Pfeffer(6) remarks that these results of Wollny were probably due to the necessary protection against transpiration in dry air retarding the gaseous exchange, and thus also carbon dioxide assimilation and growth. After citing the results of the experiment of Schloesing already referred to in this review, Pfeffer expressed the belief that transpiration favors the absorption of the constituents of the ash.

In 1905 Livingston,(7) experimenting with wheat seedlings, published the conclusion that total transpiration of wheat plants grown in various media is as good a criterion for comparing the relative growth in these media as is the weight of the plants.

Jost,(8) in 1907, without presenting any data, states in his text that plants which transpire freely are far richer in ash than those transpiring feebly. He appears to be convinced that transpiration greatly helps in the absorption from the soil of large quantities of salts.

Thatcher,(9) 1913, performed some analyses of wheat grains to determine the effect of sunlight on their composition. The plants were grown under canvas cover and in the open. In seven of nine cases he found very significantly higher percentage of

ash in the shaded plants than in those of the open. In the remaining cases the difference was in favor of the unshaded plants, but the difference was very slight. It is hardly necessary to point out that these results are not of much value to the present study, as only a part of the plant, the grain, was considered. Thatcher gives us also an account of an experiment carried out by Murinoff, at the University of Halle, in which "etiolated" plants were compared with normal green plants. It was found that the percentage of ash was slightly higher in the normal green plants.

Hasselbring,(10) in 1914, grew tobacco plants under cheesecloth and in the open. Using entire plants in the analysis, he found that the absolute amounts of dry substance were about equal in the two sets, even if the plants in the open absorbed about 28 per cent more water than did the shaded ones. He found smaller amounts of ash in the unshaded plants, but the difference is within the limits of individual variation in the same set. In another experiment the transpiration per unit area of leaf surface was nearly twice as great in the sun plants as in the shaded plants, but the total quantity of dry substance produced was the same in both sets of plants. He considers these results as a suggestion that transpiration in itself, or the mere passage of water through the plant, has no influence on the assimilatory activity, provided the water supply does not fall below a certain minimum required to maintain the turgor of the cells. In conclusion he states that the absorption of salts by roots is independent of the absorption of water and that the transpiration stream does not exert an accelerating effect on the entrance of salts.

Kiesselbach,(11) in his study of transpiration as a factor in crop production, determined the effect of various factors upon the relation of transpiration to ash content. He grew corn plants in dry and humid greenhouses. Ash determinations were made of the entire plant. It was found that there was no absolute correlation between the percentage of ash and the quantity of water transpired per gram of ash content or the transpiration per gram of dry matter.

Harris and his coworkers,(12) in a recent paper on the relationship between the osmotic concentration of leaf sap and height of leaf insertion in trees, report that the relative concentration of electrolytes decreases from lower to higher levels, and this they take to indicate that the differences are due to increased photosynthesis in the upper regions of the tree rather than to the

concentration of salts from the soil solutes by increased transpiration.

In order to obtain some sort of collective idea as to the nature of the available experimental data on the subject, the results of the different experiments are grouped in Table 1. Where more than one experiment was reported with each kind of plant, only the average is shown.

TABLE 1.—*Data on the effect of different degrees of humidity and sunlight on dry weight and ash content of plants.*

Investigator.	Plant.	Ash.		Dry substance.		Fresh substance.	
		Dry or open.	Humid or shaded.	Dry or open.	Humid or shaded.	Dry or open.	Humid or shaded.
		g.	*g.*	*g.*	*g.*	*g.*	*g.*
Hasselbring	Tobacco, entire plant.	18.25	21.08				
Do	do			188.42	188.14	993	1,163
Schloesing	Tobacco leaves	21.8	13.0	37.4	48		
		P. ct.	*P. ct.*				
Kiesselbach	Corn, entire plant	7.01	7.12	218.0	287.1		
Thatcher	Wheat grains	2.38	2.72				
Sorauer	Barley, entire plant.			0.237	0.185	3.8	3.09
Do	Pea, entire plant	11.7	10.5	0.107	0.107	1.05	1.24
Tschaplowitz (5)	*Tropaeolum majus*			1.0	1.2	8.7	10.7
Wollny	Vetch	11.67	12.46	0.4	0.5	2.0	2.82
Do	Lucerne	10.87	10.56	0.15	0.22	0.82	1.24
Do	Flax	7.89	8.11	0.11	0.13	0.44	0.63
Do	Barley	10.78	10.34	0.33	0.51	1.26	2.16

As far as the figures in Table 1 are concerned, it can easily be seen that differences in humidity and sunlight have no effect on the dry weight and ash content of the plant, and, if anything, the effect has been to make plants grown under humid or shaded conditions richer in dry matter and ash than those grown in dry or open atmosphere.

EXPERIMENTS

Material used.—The plant used in this experiment is the tobacco plant, *Nicotiana tabacum.* The seeds were obtained from the plant breeding department of the New York State College of Agriculture through the kindness of Mr. Casey Fraser, according to whom the seeds came from an inbred plant.

Germination.—The seeds used in Crop I were germinated between layers of moist filter paper in an incubation box. This method did not prove to be as convenient as was desired since it necessitated the early removal of the seedlings from the ger-

mination plates when they were still too small to be transferred into the culture medium. In Crop II, therefore, seeds were germinated in sand in a seed box.

Culture.—All plants were grown in water cultures; those of the first crop in Erlenmeyer flasks of 2,000 cubic centimenters' capacity. The nutrient solution was prepared according to the following modified Pfeffer's formula:

	Gram per liter.
Calcium nitrate	0.4
Sodium chloride	0.1
Magnesium sulphate	0.1
Monopotassium phosphate	0.1
Ferric phosphate	0.1
Potassium nitrate	0.1

To obtain different environmental conditions that should permit of different amounts of transpiration, the plants were grown in two glass chambers, each of about 432 cubic decimeters' capacity. One was "humid," the other, "dry." In the humid chamber a pan of water whose surface area was nearly equal to that of the bottom of the room was kept throughout the experiment. No pan was used in the dry chamber; instead, there was a small electric fan which was allowed to run for a portion of the time of experimentation. As the two rooms were kept closed all the time except while changing the solution or watering, provision was made for some change of air inside. A tube about 7 millimeters in diameter led from each chamber to the outside, where they met in a T-tube which was connected with a Richard's suction pump.

Some idea of the difference in relative humidity and temperature in the two culture chambers can be obtained from the temperature and Lembrecht polymeter readings which were taken at intervals on July 26 and 27 and are recorded in Tables 2 and 3.

TABLE 2.—*Temperature and humidity readings on July 26, 1917.*

No.	Time.		Humid room.		Dry room.		Weather.
			Relative humidity.	Temperature.	Relative humidity.	Temperature.	
	a. m.	*p. m.*	*Per cent.*	°*C.*	*Per cent.*	°*C.*	
1	8.00		68	29.0	55	31.0	Bright, sunny.
2		12.30	53	32.7	45	35.1	Do.
3		3.00	51	34.0	41	36.4	Do.
4		4.00	62	32.3	62	33.4	Cloudy.
5		6.00	76	28.0	70	28.1	Rainy.

TABLE 3.—*Temperature and humidity readings on July 27, 1917.*

No.	Time.		Humid room.		Dry room.		Weather.
			Relative humidity.	Temperature.	Relative humidity.	Temperature.	
	a. m.	*p. m.*	*Per cent.*	°*C.*	*Per cent.*	°*C.*	
1	8.30		82	23.1	78	23.7	Cloudy.
2	9.30		78	26.9	64	28.0	Sunny.
3	10.30		56	30.0	42	33.0	Bright, sunny.
4	11.30		50	31.0	40.5	34.4	Do.
5		12.30	49	31.9	40	35.0	Do.
6		1.30	51	31.5	44	34.0	Do.
7		2.30	54	32.0	46	34.2	Do.
8		3.30	54	32.0	48	33.5	Do.
9		4.30	61	30.5	56	31.1	Cloudy.
10		5.30	71	31.0	66	31.4	Sunny.

Analyses.—Dry weight determinations were made by drying the samples or the whole material to constant weight in an electric oven at temperatures between 105 and 110° C. To get the ash, the dried material was burned in porcelain crucibles in an electric furnace, also to constant weight. Except when otherwise stated, each plant was analyzed separately, and analyzed for ash content in root, stem, and leaves.

RESULTS OF EXPERIMENTS

CROP I

Seeds germinated, May 13, 1917.
Seedlings transferred to culture solutions, May 17, 1917.
Plants placed in dry and humid chambers, June 13, 1917.
Solutions changed, June 29, July 16, July 29, and August 13, 1917.

HARVEST I, JULY 25, 1917

The heights of all the plants on the day of the first harvest are given in Table 4.

TABLE 4.—*Heights of plants on the day of the first harvest.*

Plant No.	Humid.	Dry.
	cm.	*cm.*
1	21.5	20.5
2	19.7	19.5
3	20.0	18.9
4	17.7	16.8
5	16.2	12.0
6	11.5	17.4
7	4.3	14.0
8	10.0	11.5
9	4.5	12.0
Average	13.9	15.8

In this harvest only three plants were taken as samples from each chamber; namely, plants 5, 6, and 8 from the humid room and plants 4, 8, and 9 from the dry room.

The average height of the harvested plants, number of leaves per plant, average length of roots, and average weight of roots, stems, and leaves per plant were determined, and the figures in Table 5 were obtained.

TABLE 5.—*Data from harvested plants.*

Average—	Humid.	Dry.
Height of plants ... cm	12.6	13.4
Number of leaves	12.6	12.6
Length of leaves ... cm	21.1	33.0
Weight of fresh roots ... g	0.156	0.495
Weight of fresh stems ... g	1.403	1.563
Weight of fresh leaves ... g	4.516	5.426

Tables 6 and 7 contain the figures obtained from moisture and ash determinations, respectively; the percentages of moisture are based on fresh weights, while those of ash were figured on the dry-weight basis.

TABLE 6.—*Moisture content.*

	Humid.	Dry.
	Per cent.	*Per cent.*
Roots	66.5	79.6
Stems	92.8	92.9
Leaves	86.7	92.1

TABLE 7.—*Ash content (average of three plants).*

	Humid.	Dry.
	Per cent.	*Per cent.*
Roots	8.19	6.64
Stems	8.02	7.72
Leaves	10.44	11.05

HARVEST II, AUGUST 19, 1917

Tables 8, 9, 10, and 11 contain the data obtained from analyses of the second harvest. The lengths of tops and roots and the total number of leaves at the harvest time are given in Table 8. Table 9 contains the dry weights; Table 10, the percentages of ash; and Table 11, the absolute dry weights and percentages of total ash.

TABLE 8.—*Lengths of tops and roots and total number of leaves.*

Plant No.	Humid.			Dry.		
	Length of top.	Length of roots.	Leaves.	Length of top.	Length of roots.	Leaves.
	cm.	*cm.*		*cm.*	*cm.*	
1	57.6	27.5	19	34.5	27.0	16
2	51.2	26.5	19	33.0	24.5	16
3	43.7	28.0	17	46.5	29.0	17
4	23.5	23.0	16	37.8	23.5	16
5	51.0	22.0	18	44.6	23.5	19
6	25.5	24.5	14	50.5	24.5	17
Average	42.1	25.2	17.2	41.1	25.3	16.8

TABLE 9.—*Absolute dry weights.*

Plant No.	Humid.			Dry.		
	Roots.	Stem.	Leaves.	Roots.	Stem.	Leaves.
	g.	*g.*	*g.*	*g.*	*g.*	*g.*
1	0.5140	1.3895	1.4144	0.3629	0.7836	1.2568
2	0.5560	1.1641	1.6279	0.4153	0.7756	1.3993
3	0.3624	0.9910	1.3770	0.5610	1.1734	1.7679
4	0.2209	0.3829	0.8667	0.3288	0.9837	1.2375
5	0.4241	1.1150	1.5710	0.5307	1.0878	1.5372
6	0.2055	1.4174	0.8283	0.5934	1.2200	1.6020
Average	0.3805	1.0766	1.2809	0.4653	1.0040	1.4668

TABLE 10.—*Percentage of ash in individual plants.*

Plant No.	Humid.			Dry.		
	In roots.	In stem.	In leaves.	In roots.	In stem.	In leaves.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1	6.13	3.20	5.50	6.83	3.62	5.94
2	7.24	3.60	6.07	6.54	3.88	6.53
3	8.14	3.47	4.77	7.62	3.39	5.38
4	8.42	5.17	8.33	7.02	3.31	6.14
5	7.34	3.60	5.52	7.68	3.60	6.19
6	6.91	5.22	8.18	7.11	3.55	6.47
Average	7.36	4.04	6.39	7.13	3.56	6.11
Probable error of mean [a]	±0.21	±0.23	±0.38	±0.11	±0.05	±0.11

[a] Probable error of the average was calculated according to the formula:

$$P.\ E. = \sqrt{\frac{\Sigma fd^2}{n}} \times \frac{0.6745}{\sqrt{n}}$$

P. E., probable error of the mean; Σfd^2, summation of the squares of the deviations of the values from the mean; n, number of individuals; 0.6745, a constant.

TABLE 11.—*Total dry weights and percentages of total ash.*

Plant No.	Humid.		Dry.	
	Dry matter.	Ash.	Dry matter.	Ash.
	g.	*P. ct.*	*g.*	*P. ct.*
1	3.3179	4.64	2.4033	5.31
2	3.3480	5.41	2.5902	5.74
3	2.7304	4.75	3.5023	5.07
4	1.4705	7.52	2.5500	5.16
5	3.1101	5.08	3.1557	5.55
6	2.4512	6.36	3.4154	5.54
Average	2.7380	5.63	2.9361	5.39
Probable error of mean	±0.1790	±0.28	±0.1206	±0.06

CROP II

Crop II consisted of two series; one series was kept in the same chambers in which Crop I was grown and is a repetition of Harvest I of that crop. This repetition was thought to be necessary as in Harvest I of Crop I no ash determinations were made of individual plants, and so the individual variation as well as the probable error of the average could not be determined. The second series of Crop II was grown in glass chambers also in which temperature and relative humidity were not supposed to be the factors controlling the relative rates of transpiration but rather the different intensity of illumination. One of the chambers was covered with white canvas cloth, and the other was left uncovered. The doors of both rooms were left open a little throughout the experiment to allow some circulation of air. The opening, however, did not interfere with the method of shading. Each chamber had a capacity of about 500 cubic decimeters.

The seeds used were from the same lot of seeds as those used in the first crop. This time, they were germinated in previously well-mixed sand in a seed box. The culture solution was prepared according to the formula that was used in Crop I, but the culture flasks were 250-cubic-centimeter Erlenmeyer. Change of solution and replacement of water lost by transpiration and otherwise were more frequent.

SERIES I. UNDER HUMID AND DRY ATMOSPHERE

Seeds germinated, July 23, 1917.
Seedlings transferred to culture flasks, July 30, 1917.
Plants placed in culture chambers, August 20, 1917.

Solutions changed, August 13, 20, and 25, and September 3, 10, and 19, 1917.

Harvested, September 22, 1917.

TABLE 12.—*Lengths of tops and roots and the number of leaves of the plants at the time of harvest.*

Plant No.	Humid.			Dry.		
	Length of top.	Length of roots.	Leaves.	Length of top.	Length of roots.	Leaves.
	cm.	*cm.*		*cm.*	*cm.*	
1	6.0	27.0	11	5.0	26.9	11
2	6.0	18.5	11	5.5	26.0	8
3	6.4	19.0	10	5.0	35.1	11
4	5.5	23.0	9	5.0	19.0	11
5	7.5	25.0	12	4.5	29.5	12
6	5.7	28.7	10	5.0	28.5	10
Average	6.2	23.5	10.5	5.0	27.5	10.5

In order to get an idea of the effect of the difference in humidity in the two culture chambers upon the relative rates of transpiration of the plants, the amount of water transpired by the individual plants for four consecutive weeks was determined by weighing plants and containers at intervals during a part of the time of the experiment. It should be stated that precautions were taken to prevent as much as possible the loss of water through other processes than transpiration or evaporation from the plants. Table 13 gives the results.

TABLE 13.—*Water transpired from August 25 to September 22.*

Plant No.	Humid.	Dry.
	g.	*g.*
1	153.6	228.0
2	144.0	220.0
3	139.0	208.0
4	132.4	209.6
5	142.0	218.0
6	154.0	263.6
Average	144.2	224.5

Tables 14 and 15 contain the results of the dry weight and ash determinations.

The data on the amount of water transpired for four weeks, the weight of total dry matter, and the percentages of total ash are combined in Table 16. In Table 17 are given the amounts of dry weight and ash per 100 cubic centimeters of water transpired.

TABLE 14.—*Absolute dry weights of parts of plants.*

Plant No.	Humid.			Dry.		
	Roots.	Stems.	Leaves.	Roots.	Stems.	Leaves.
	g.	*g.*	*g.*	*g.*	*g.*	*g.*
1	0.0980	0.0398	0.2645	0.0973	0.0428	0.3214
2	0.0930	0.0469	0.2928	0.0867	0.0360	0.2923
3	0.0912	0.0553	0.2801	0.0816	0.0393	0.2502
4	0.0881	0.0403	0.2661	0.0652	0.0359	0.1959
5	0.1052	0.0513	0.3283	0.0890	0.0356	0.2590
6	0.0994	0.0388	0.2314	0.0922	0.0366	0.2837
Average	0.0958	0.0454	0.2772	0.0853	0.0377	0.2671

TABLE 15.—*Percentage of ash in parts of plants.*

Plant No.	Humid.			Dry.		
	In roots.	In stems.	In leaves.	In roots.	In stems.	In leaves.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1	8.88	8.54	7.98	8.22	7.01	5.97
2	10.32	7.25	6.80	10.61	6.53	7.59
3	9.54	7.78	6.57	9.68	6.52	8.55
4	8.85	8.18	7.29	9.81	6.92	10.26
5	9.41	7.21	7.09	8.43	7.21	8.41
6	9.25	7.99	6.83	8.02	6.48	8.74
Average	9.38	7.83	7.09	9.13	6.78	8.25
Probable error of average	±0.14	±0.13	±0.13	±0.26	±0.08	±0.36

TABLE 16.—*Water transpired for four weeks, absolute dry weights, and the percentage of total ash.*

Plant No.	Humid.			Dry.		
	Water transpired in 4 weeks.	Dry matter.	Ash.	Water transpired in 4 weeks.	Dry matter.	Ash.
	g.		*P. ct.*	*g.*		*P. ct.*
1	153.6	0.4023	8.25	228.0	0.4615	6.54
2	144.0	0.4327	7.61	220.0	0.4150	8.13
3	139.0	0.4266	7.36	208.0	0.3711	8.58
4	132.4	0.3945	7.73	209.6	0.2970	9.76
5	142.0	0.4848	7.61	218.0	0.3836	8.31
6	154.0	0.3696	7.60	263.6	0.4125	8.38
Average	144.2	0.4184	7.69	224.5	0.3901	8.28
Probable error of mean	----------	±0.0100	± 0.08	----------	±0.0139	±0.26

TABLE 17.—*Proportion of dry weight and ash to 100 cubic centimeters of transpired water.*

Humid.	
Water (cc.)	100.
Dry weight (g.)	0.2901
Ash (g.)	0.0223
Dry.	
Water (cc.)	100.
Dry weight (g.)	0.1292
Ash (g.)	0.0107

SERIES II. SHADED AND UNSHADED

Seeds germinated, July 23, 1917.
Seedlings transferred to culture flasks, July 30, 1917.
Plants placed in shaded and unshaded chambers, August 20, 1917.
Solutions changed, August 13, 20, and 25, and September 3, 10, 19, and 30, 1917.
Harvested, October 2, 1917.

TABLE 18.—*Lengths of tops and roots and total number of leaves.*

Plant No.	Humid.			Dry.		
	Length of top.	Length of roots.	Leaves.	Length of top.	Length of roots.	Leaves.
	cm.	*cm.*		*cm.*	*cm.*	
1	12.0	15.5	11	3.2	21.5	12
2	10.9	14.5	11	5.5	24.5	11
3	11.5	22.5	10	4.0	24.5	10
4	11.0	19.5	11	4.8	22.3	10
5	13.0	22.5	11	4.8	24.2	10
6	10.1	25.1	10	3.2	20.5	11
7	10.0	16.5	12	3.7	16.5	12
8	9.5	18.1	10	3.9	18.5	10
9	8.5	17.0	11	4.1	19.1	11
10	6.5	19.5	19	4.6	25.3	11
11	9.8	18.1	10	3.4	20.1	10
12	10.2	20.5	10	4.8	26.5	11
Average	10.2	19.1	11.3	4.2	22.0	10.8

Tables 20, 21, and 22 contain the results of the dry weight and ash determinations; Table 23, the amounts of dry weight and ash per 100 cubic centimeters of water transpired.

DISCUSSION OF RESULTS

Transpiration.—From Tables 13 and 19 it can be seen that in both types of experiments, humid-dry and shaded-unshaded, the desired differences in conditions of relative humidity and sunlight were obtained to give a difference in the relative rates of transpiration.

TABLE 19.—*Water transpired from August 25 to September 22, 1917.*

Plant No.	Shaded.	Un-shaded.
	g.	g.
1	161.2	230.4
2	162.8	251.6
3	172.0	278.0
4	178.0	259.6
5	180.0	270.0
6	176.4	213.0
7	147.6	222.0
8	189.6	272.0
9	136.0	276.0
10	95.2	266.0
11	138.4	240.0
12	112.0	272.4
Average	154.1	254.2

TABLE 20.—*Dry matter.*

Plant No.	Shaded.			Unshaded.		
	In roots.	In stems.	In leaves.	In roots.	In stems.	In leaves.
	g.	g.	g.	g.	g.	g.
1	0.0938	0.0711	0.3381	0.0700	0.0351	0.4020
2	0.0908	0.0719	0.3064	0.1473	0.0499	0.4468
3	0.0827	0.0738	0.3142	0.1684	0.0393	0.4637
4	0.0966	0.0646	0.3442	0.1637	0.0419	0.4587
5	0.1090	0.0813	0.3504	0.1934	0.0445	0.4621
6	0.0850	0.0550	0.2964	0.0845	0.0283	0.3580
7	0.0643	0.0546	0.2573	0.0994	0.0557	0.3763
8	0.0992	0.0590	0.3589	0.1579	0.0314	0.4316
9	0.0595	0.0474	0.2675	0.1362	0.0413	0.3940
10	0.0300	0.0319	0.1706	0.1438	0.0455	0.4636
11	0.0620	0.0527	0.2297	0.1324	0.0371	0.3962
12	0.0534	0.0455	0.1896	0.1580	0.0460	0.4190
Average	0.0772	0.0591	0.2853	0.1379	0.0413	0.4227

Physical characters of plants.—Considering first the crop grown in humid and dry chambers, there is found a general tendency for the roots of the "dry" plants to become longer. In Table 5 there is a difference of 11.9 centimeters and in Table 12, one of 4 centimeters in favor of the "dry" roots. In a third series this difference was insignificant, amounting to only 0.1 centimeter. There was no significant difference in the length of top and the number of leaves.

When the crop grown in shaded and unshaded chambers is considered it is seen (Table 18) that here also the roots of the unshaded plants were longer, the difference being 2.9 centi-

meters. The tops of the shaded plants averaged 6 centimeters longer than those of the unshaded. There was no important difference in the number of leaves. The leaves of those in the shaded chamber were longer, broader, thinner, and of better quality.

TABLE 21.—*Percentages of ash.*

Plant No.	Shaded.			Unshaded.		
	In roots.	In stems.	In leaves.	In roots.	In stems.	In leaves.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1	9.81	7.59	9.20	11.00	7.62	6.99
2	8.04	8.20	10.54	10.79	7.89	7.52
3	8.10	9.35	10.40	11.04	9.40	7.46
4	8.18	8.04	10.05	10.87	7.55	7.54
5	8.07	9.47	10.58	8.54	10.00	8.39
6	8.59	10.19	11.84	8.75	9.27	7.32
7	7.93	10.80	11.93	6.94	11.01	7.12
8	9.48	10.16	9.69	9.25	14.01	7.60
9	9.08	12.02	11.81	11.01	10.89	8.10
10	11.33	13.48	15.41	10.85	11.89	6.46
11	8.55	11.00	14.02	10.55	11.59	8.45
12	8.43	12.08	16.18	11.07	10.87	7.82
Average	8.80	10.20	11.80	10.06	10.17	7.56
Probable error of mean	±0.26	±0.39	±0.59	±0.35	±0.51	±0.12

TABLE 22.—*Water transpired in four weeks, absolute dry weights, and percentages of total ash.*

Plant No.	Shaded.			Unshaded.		
	Water transpired in four weeks.	Dry matter.	Ash.	Water transpired in four weeks.	Dry matter.	Ash.
	g.	*g.*	*P. ct.*	*g.*	*g.*	*P. ct.*
1	161.2	0.5030	9.10	230.4	0.5071	7.59
2	162.8	0.4691	9.72	251.6	0.6440	8.29
3	172.0	0.4707	9.83	278.0	0.6714	8.47
4	178.0	0.5054	9.43	259.6	0.6643	8.36
5	180.0	0.5407	9.35	270.3	0.7000	8.54
6	176.4	0.4364	11.02	213.0	0.4708	7.68
7	147.6	0.3762	11.08	222.0	0.5314	7.49
8	189.6	0.5171	9.70	272.0	0.6209	8.63
9	136.0	0.3744	11.21	276.0	0.5715	8.99
10	95.2	0.2325	14.62	266.0	0.6529	7.76
11	138.4	0.3444	12.57	240.0	0.5657	9.15
12	112.0	0.2885	14.11	272.4	0.6230	8.87
Average	154.1	0.4215	10.98	254.2	0.6019	8.32
Probable error of mean		±0.02	±0.49		±0.02	±0.15

TABLE 23.—*Proportion of dry weight and ash to 100 cubic centimeters of water transpired.*

Shaded.	
Water (cc.)	100.
Dry weight (g.)	0.2735
Ash (g.)	0.0300
Unshaded.	
Water (cc.)	100.
Dry weight (g.)	0.2367
Ash (g.)	0.0197

The single fresh-weight determination made in this study (Table 5) showed that the "dry" plants were heavier.

Dry matter.—Determinations of dry weight as well as of ash were made, not only of the entire plant, but also of roots, stems, and leaves separately in order to determine if the relative amounts of dry matter and ash vary in different parts of the plant. Information on this particular point ought to be of value in considering the merit of the data heretofore reported by different investigators for only a portion of the plant. Except in one case, analysis was of individual plants in order that the probable error due to individual variation could be determined.

Ash.—Ash is reported in the foregoing tables as percentage of dry weight, except in Tables 17 and 23. Since both the dry weight and the corresponding percentage of ash are given, the amount of ash, if desired in other cases, can be calculated very easily. In the younger crop it is seen (Table 7) that the percentage of ash in the roots and stems of the "humid" plants is greater than that in those of the "dry" ones; while in the case of leaves, the difference, though small, is in favor of the "dry" plants. As probable errors were not determined in this particular case, nothing can be said about whether or not the differences are significant. Taking the data in Table 15, which represent the percentages of ash in another, younger crop, the above comparison still holds and it is to be seen that the difference is significant for the stems. Taking the dry weight of the entire plant (Table 16) of the same crop, there was more dry matter in the "humid" than in the "dry" plants, but a slightly smaller percentage of total ash. If the total amount of ash is calculated, it will be found that in this the two crops do not differ.

In the case of the older crop in dry and humid conditions, the differences in percentages of ash in roots, stems, and leaves are all in favor of the humid plants (Table 10), but the reverse

is true in total dry matter, the difference, however, being insignificant (Table 11).

From the results with the single crop grown in shaded and unshaded chambers we find (Table 21) that the shaded plants have higher average percentages of ash in stems and leaves and lower percentages in roots than the unshaded ones. The total dry matter (Table 22) of the unshaded plants was higher, owing probably to the difference in relative rates of carbon dioxide assimilation, but in percentage of total ash the difference, which is very significant, is in favor of the shaded plants.

In Tables 16 and 22 the amount of water transpired by individual plants in the period of four weeks is placed side by side with the amount of total dry matter and percentage of total ash in each plant. Assuming that the relative amounts of water transpired in four weeks of the crops' lifetime is a fair index of the total amount of water transpired in the whole life period of the crops, the data in Tables 16 and 22, whether only for plants grown in humid or shaded atmosphere or only for those grown in dry or unshaded rooms, should furnish an indication as to whether or not the absorption of mineral salts is directly proportional to the relative rates of transpiration. In Table 16 it will be seen that in the humid crops the plant which transpired the greatest amount of water in four weeks did not have the greatest amount of dry matter or the highest percentage of ash; neither did the plant with the lowest transpiration have the lowest dry weight or percentage of ash. The same is true with the crop grown in the dry chamber. In the shaded and unshaded crop, the plants having the lowest transpiration had the least dry weights, but not the lowest percentages of ash; those with the highest amounts of transpired water again did not have the largest percentages of ash or the largest amounts of dry matter. In Tables 17 and 23 the amount of dry matter and ash corresponding to 100 cubic centimeters of water transpired are given. For 100 cubic centimeters of transpired water we see that the "humid" or "shaded" plants average higher in absolute weight of ash and dry matter.

CONCLUSION

The results of the present experiments show that in tobacco plants grown in water culture, there was no absolute correlation between the percentage of ash, the relative rates of transpiration, and the total dry matter.

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LITERATURE CITED

1. LAWES, J. B. Experimental investigation into the amount of water given off by plants during their growth; especially in relation to the fixation and source of their various constituents. Journ. Hort. Soc. London **5** (1850) 38–63.
2. SCHLOESING, TH. Tabac sous cloche et a l'air libre. Ann. Sci. Nat. Bot. V **10** (1869) 366–369.
3. SORAUER, P. Der Einfluss der Luftfeuchtigkeit. Bot. Zeit. **36** (1878) 1–13, 17–25.
4. SORAUER, P. Studien über Verdunstung. Forschungen auf dem Gebiete der Agrikultur Physik **3** (1880) 351–490.
5. WOLLNY, W. Untersuchungen über den Einfluss der Luftfeuchtigkeit auf das Wachstum der Pflanzen. Inaug. Diss. Halle (1898).
6. PFEFFER, W. The physiology of plants **1** (1900) 235.
7. LIVINGSTON, B. E. Relation of transpiration to growth in wheat. Bot. Gaz. **40** (1905) 178–195.
8. JOST, L. Lectures on plant physiology (1907) 43, 79.
9. THATCHER, R. W. The chemical composition of wheat. Washington State Bull. **111** (1913).
10. HASSELBRING, H. The effect of shading on the transpiration and assimilation of the tobacco plant in Cuba. Bot. Gaz. **57** (1914) 72, 257.
11. KIESSELBACH, T. A. Transpiration as a factor in crop production. Bull. Nebr. Agr. Exp. Sta. Res. **6** (1916) 170.
12. HARRIS, J. A., GORTNER, R. A., and LAWRENCE, J. V. The relationship between the osmotic concentration of leaf sap and height of leaf insertion in trees. Bull. Torrey Bot. Club **44** (1917) 267–286.

SAPINDACEAE NOVAE PHILIPPINENSES

Auctore L. RADLKOFER

LEPISANTHES ACUTISSIMA Radlk. sp. nov.

Frutex mediocris, glaber, cauliflorus; trunci ramique flavescenti-cani, teretes, lenticelloso-punctati; folia paripinnata, 2-vel 3-juga, petiolo tereti elongato striato; foliola lanceolato-oblonga, in acumen elongatum acutissimun sensim attenuata, basi inaequaliter obtusata (latere exteriore paullulo latiore longioreque) petiolulis breviusculis subcylindricis hirtellis insidentia, chartacea, nervis lateralibus remotiusculis procurvis, flavo-viridia, utrinque opaca, praeter nervum medianum subtus pilis brevibus laxe adspersum glabra, glandulis praesertim supra profunde immersis ornata, epidermide paginae inferioris sparsim (plerumque in cellulis geminatis) crystallorum concretiones parvas gerente; thyrsi ad trunci basin (10 cm supra solum) pauci fasciculati, breviusculi, dense cincinnigeri; flores mediocres; sepala flavide tomentosa, intus glabra; petala 5, lanceolata, unguiculata, dorso praeter marginem sericeo-tomentosa, intus glabra et supra unguem squama brevi biloba deflexa glabriuscula aucta; discus regularis, tomentellus; stamina 8, apice pilosa, antherae glabriusculae; germen trigono-ovatum, triloculare, dense flavo-tomentosum, in stylum apice glabrum attenuatum, loculis intus infra gemmularum insertiones dense pilosis; fructus (non suppetebat).

Frutex 1–2 m altus, truncis digitum crassis. Rami foliati 4–5 mm crassi. Folia petiolo 10–12 cm longo adjecto ad 45 cm longa; foliola superiora cum petiolulis 5 mm longis ad 30 cm longa, 8.5 cm lata, inferiora fere dimidio minora. Thyrsi 4 cm longi. Flores 5 mm longi, albi.

In Philippinarum insula Palawan: *Merrill n. 9564!* (ad lacum Manguao, alt. 80 m, m. Mai 1913, fl.; comm. ex Hb. Manil.).

Obs. Inter species floribus regularibus germineque 3-loculari praeditas excellens inflorescentiis ad trunci basin erumpentibus discoque tomentello.

LEPISANTHES MACROCARPA Radlk. sp. nov.

Frutex mediocris; folia paripinnata, 4-juga, petiolo tereti breviter sufferrugineo-tomentoso; foliola inferiora ovata, supe-

riora plus duplo majora elliptica, omnia acuta, basi obtusa petiolulis longiusculis tumidis tomentosis insidentia, integerrima, chartacea, nervis lateralibus approximatis obliquis subtus prominentibus, supra praeter nervum medianum hirtellum glabra, laeviuscula, pallide viridia, subtus pilis subulatis patulis hirta, utrinque glandulis profunde immersis ornata; flores (non suppetebant); fructus major, bilocularis, e transversim ellipsoideo subcylindraceus, inter loculos sulco levi, septi margini respondenti exaratus, inde subbicoccus, basi sepalorum reliquiis tomentosis suffultus, apice subapiculatus, pericarpio corticoso-coriaceo tomento hirto fusce ochraceo obducto, dein ± glabrato, mesocarpio e concretionibus sclerenchymaticis conflato, endocarpio membranaceo tenuissime fibroso non solubili pilis paucis subsetaceis e pede fusiformi inter endocarpii fibros superficiales interjecto emergentibus adsperso; semen globosum, ad loculi basin septo affixum, testa tenuiter coriacea laevi brunnea; embryo erectus, obsolete notorrhizus, cotyledonibus hemisphaericis oblique juxtapositis farinaceo-carnosis albidis, radicula brevi micropylen versus curvata.

Frutex ca. 1-metralis. Folia petiolo 10 cm longo adjecto 60 cm longa; foliola inferiora cum petiolulis 1 cm longis 13 cm longa, 6 cm lata, superiora 30 cm longa, 12 cm lata. Fructus 4–4.5 cm latus, 2 cm altus et crassus. Semen diametro 1.5 cm.

In Philippinarum insula Luzon: *M. Ramos n. 19460!* (prov. Tayabas, in monte Pular, m. Jan. 1913, fr.; comm. ex Hb. Manil.).

Obs. Affinis Lepisanthi eriolepidi Radlk., a qua differt foliolis acutis, fructu majore, endocarpio non solubili.

HEDYACHRAS Radlk. (gen. nov.) in Engl. Bot. Jahrb. **56** (1920) 258, annot: (charact. brevis)

Flores minores, spurie polygami, masculi numerosi et feminei (hermaphroditos mentientes) pauci in iisdem inflorescentiis. Calyx 4-sectus, segmentis deltoideis subinduplicato-valvatis, denique horizontaliter expansis, immo reflexis, extus subfulvo-tomentosis, intus cano-pubescentibus, pressione staminum et antherarum striatis. Petala 0. Discus fundum calycis vestiens, patellaris, glaber, margine crenulatus nigro-fuscus. Stamina (an semper ?) 6, (floris ♀ brevia) filiformia, intra discum inserta glabra, in alabastro supra discum arcuatim expansa, apice inflexa (inde bis curvata), dein exserta; antherae tumide deltoideae, apice retusae, basi excisae, dorso supra excisuram affixae, introrsae, connectivo dorso dilatato, glabrae, in alabastro arcte conniventes; pollinis granula trigono-globosa triporosa,

parva. Germen (floris ♂ rudimentarium) in disci centro sessile, tumide obcordatum, 2-loculare, inter loculos sulco exaratum, densissime tomentosum, stylo brevissimo conico sulco suturali notato sub tomento ± occulto superatum. Gemmulae, in loculis solitariae, axeos tuberculo basali insidentes, erectae sub-campylotropae, micropyle extrorsum infera. Fructus magnus carnosus indehiscens, compressiuscule pyriformis pyrique mediocris magnitudine, ± glabratus, fragrans, edulis, sapore grato (inde generis nomen), 2- vel abortu 1-spermus. Semen oliviforme exarillatum, testa tenuiter crustacea, endocarpio e cellularum filiforminum collenchymaticarum stratis decem pluribusve conflato arcte adhaerente spadicea glabra. Embryo erectus, parum curvatus; cotyledones crassae, carnoso-farinosae, ± conferruminatae, siccae induratae, inaequales, oblique superpositae, dorsali (superiore) majore apice crassiore intus concavo, ventrali (an semper ?) minore basi crassiore biconvexa, plano commissurali inde in directione longitudinali et transversali curvato; radicula ad seminis basin perparva papilliformis.

Arbor sat alta. Rami teretes, striati, tomento isabellino vestiti, lenticellis linearibus seriatis notati. Folia abrupte pinnata, 4- ad 6-juga, sat petiolata, exstipulata; foliola majuscula, inferiora ovata, superiora longiora ex oblongo lanceolata utrinque acuta vix acuminata, petiolulis brevibus a dorso complanatis basi dilatatis suffulta, integerrima, subundulata, chartacea, nervis lateralibus utrinque ca. 12 obliquis margine sursum versis et ± anastomosantibus subtus magis quam supra prominentibus, praeter nervum medianum puberulum glabra, subtus in axillis nervorum barbulata, glandulis microscopicis longiusculis fugacibus utrinque adspersa, supra livescenti-viridia nitidula, subtus flavescenti-viridia, impunctata, cellulis secretoriis nullis, diachymate e cellulis staurenchymaticis superioribus longioribus inferioribus sensim brevioribus conflato, epidermide non mucigera; petiolus rhachisque supra costa mediana obtusa notata glabriuscula, subtus convexa striata pube molli sordida adspersa. Panicula in ramulis foliatis terminalis, robusta folia vicina aequans vel paullo superans, a basi divaricatim ramosa, subferrugineo-tomentella, ramis thyrsoideis elongatis (arcus parte convexa plerumque sursum versa) fere a basi rhachique superne dichasiis breviter stipitatis in cincinnos abeuntibus compacte multifloris inferioribus approximatis superioribus in verticillos quodammodo distantes congestis dense obsitis; bracteae bracteolaeque ovato-lanceolatae, tomentellae. Alabastra globosa, seminis Brassicae Rapae magnitudine, cum pedicellis brevibus

pube brevi densissima crispula sordide fulva induta, pedicellis prope basin articulatis cicatrices fuscas pube canescente cinctas arcte congestas relinquentibus.

Obs. Genus ob fructum indehiscentem subintegrum et semen exarillatum Tribui Melicoccearum adsciendum videtur, generibus "Castanospora" et "Tristira" accedens, cum ulteriore floribus apetalis conveniens.

HEDYACHRAS PHILIPPINENSIS Radlk. l. c. (nomen) sp. nov. Character ut supra.

Arbor 15–18 m alta, trunco 30–33 cm diametro. Folia petiolo 9 cm longo adjecto ca. 40 cm longa, superiora paniculae vicina fere dimidio minora; foliola cum petiolulis 5 mm longis ad 18 cm longa, 6.5–7 cm lata, infima summaque minora, 9–12 cm longa, 5–6.5 cm lata. Panicula ad 22 cm longa, ramis inferioribus 18 cm longis. Flores diametro 5 mm. Pedicelli 2–4 mm, fructigeri 1.3 cm longi. Sepala 2 mm longa, 1.5 mm lata. Stamina 3 mm longa. Fructus (siccus) 6 cm longus, 4.5–5.5 cm crassus. Semen 3 cm longum, 2–2.3 cm crassum.

In Philippinarum insula Luzon: *A. Villamil n. 20635!* (prov. Laguna, ad montem Maquiling, secundum flumen Molauin, in campo instituti agronomici, alt. 30 m, m. Nov. 1914, fruct.; comm. ex Hb. Manil.).

EUPHORIANTHUS OBTUSATUS Radlk. in lit. ad S. H. Koorders (1897), nomine a Koorders edito in Fl. Minahassae, Meded. Plantent. **19** (1898) 406; Radlk. in Engl. & Pr. Nat. Pfl.-Fam. Nachtr. III, Ergänz.-Heft II (1907) 206 (character brevis); Koord.-Schum. Syst. Verz. **3** Celebes (1914) 75, coll. *18819* β. *18848* β;-Sapindac. spec. Koord.-Schum. l. c. 76, coll. *18839* β;-E. sp. Koorders l. c. p. 222. Vulgo "Woesel" sive "Tompinis-in-taloen" in lingua Tontemboan; "Boesel-in-Koko," sive "Woesel-in-Koko," in lingua Toelooer in Celebes t. Koord. l. c. sub. E. obtus.; "Soesoei" in insulae Celebes districtu Tonsavang t. Koord. l. c. sub E. sp.

Arbor; rami teretiusculi, sulcati petiolique ochraceo-tomentelli; folia abrupte pinnata; foliola 10–16 alterna, oblonga, obtusa, basi subcuneata, longius breviusve petiolulata, submembranacea, multinervia, nervis utrinque 15–20 obliquis subtus prominentibus, praeter nervos utrinque puberulos glabriuscula nec nisi glandulis breviter vermicularibus adspersa, utrinque laevia, nitidula, pallide viridia, cellulis secretoriis instructa; paniculae ad apices ramorum axillares, folia subaequantes; flores fructusque generis.

Rami 5–6 mm crassi. Folia petiolo 6–8 cm longo adjecto 30–40 cm longa; foliola cum petiolulis 5–10 mm longis ad 16 cm

longa, 4.5 cm lata. Paniculae 24–30 cm longae, ramis 5–10 cm longis; bracteae bracteolaeque lanceolatae, tomentellae; pedicelli 1.5 cm longi, supra medium articulati. Capsula diametro 2 cm.

In Celebes et Philippinis: *Koorders 18819 β!* (Celebes prov. Minahassa m. Apr. 1895, fl.; Hb. Bog. et ex hoc commc. Hb. Monac.), *18839 β!* (ibid. fr.), *18848 β* (ibid. ex Koord.-Schum. l. c.) ; *D. P. Miranda 18274!* (in Philippinarum insula Mindanao, distr. Cotabato, m. Mai-Jun. 1912, fl; comm. ex Hb. Manil.).

Obs. Valde affinis E. longifolio (Roxb.) Radlk. speciei celebico-moluccano-papuasicae, quae differt foliolis acutis, chartaceis, subtus opacis.

TRIGONACHRAS FALCATOCUSPIDATA Radlk. sp. nov.

Arbor; rami teretes, glabri, nigro-fusci, foliola abrupte pinnata, petiolo rhachique teretiusculis glabris, foliola 6–8, opposita, breviuscule ovato-lanceolata, parum inaequilatera, apice abruptius in acumen acutum falcatum attenuata, longiuscule petiolulata, rigidiuscule coriacea, nervis lateralibus subtilibus procurvis retique venarum supra prominulis, glabra, supra nitida, subtus opaca et interdum basi glandulis maculiformibus paucis notata, saturate, viridia, crebre pellucido-punctata, epidermide mucigera; paniculae thyrsive ad apicem ramorum axillares, folia superantes, dichasia pluriflora vel apice cincinnos gerentes, rhachi ramisque pedicellisque subferrugineo-pulverulento-puberulis; flores generis sat pedicellati; capsula magna, trigono-clavata obtusa, glabra, (sicca) rubro-spadicea, intus tomentoso alutaceo vestita; semen infra medium loculum affixum, ellipsoideum, testa coriaceo-crustacea spadicea laevi exarillata.

Rami 4 mm crassi. Folia petiolo 3–4 cm longo adjecto ca. 18 cm longa; foliola cum petiolulis 6–8 mm longis 8–10 cm longa, 2.2–3.4 cm lata. Paniculae ad 20 mm longae. Pedicelli 2–3 mm, fructigeri 5–6 mm longi. Flores 3 mm alti et lati. Calycis segmenta late ovata puberula, intus glabra; petala ex elliptico subrhombea, in unguem denique aequilongum attenuata, calycem subduplo superantia, 3 mm longa, intus supra unguem squamulis 2 cuneatis cristatis aucta, basi margine ut et unguis squamulaeque dense villosa, albida, pellucido-punctata; discus crassiuscule annularis, glaber; stamina pilosa longius exserta, 5 mm longa, antheris clavatis glabriusculis; germen (fl. ♂) rudimentarium trigono-globosum, puberulum. Capsula 4–5 cm longa, 2.5–3 cm lata. Semen 1.2 cm longum, 7 mm crassum.

In Philippinarum insula Luzon. *M. Ramos 20467*; (San Antonio, prov. Laguna, m. Febr. 1913, fl.), *14920*; (ibidem, m. Jun. 1912, fr.; comm. ex Hb. Manil.).

Obs. Fructus indole accedit ad T. cuspidatum, foliorum indole ad T. rigidam.

MISCHOCARPUS SUBLAEVIS Radlk. sp. nov.

Rami teretiusculi, verruculoso-lenticellosi, glabri; folia abrupte pinnata, petiolo rhachique striatis; foliola ca. 6, opposita, oblongo-lanceolata, utrinque acuta, petiolulata, integerrima, coriacea, nervis lateralibus sat approximatis patentibus, reti venarum angusto utrinque vix prominulo, inde subtus quoque sublaevia et nitidula, obsolete pellucido-punctata, efoveolata; paniculae subterminales pauciramosae, quam folia breviores, adpresse puberulae; flores longius pedicellati, apetali, calyx et discus laxe, stamina et germen densius puberula; discus annularis, dein dilatatus, circumcirciter declinatus, pluricostatus, inter costas sulcis latiusculis exaratus; fructus (non suppetebat).

Rami 8 mm crassi. Folia petiolo 8 cm longo adjecto ad 40 cm longa; foliola cum petiolulis 1 cm longis ad 20 cm longa, 7.5 cm lata. Paniculae 25 cm longae; pedicelli 3–4 mm longi prope basin articulati; bracteae perparvae. Flores expansi vix 2 mm lati.

In Philippinarum insula Leyte: *C. A. Wenzel 600!* (m. Mai-Jul. 1914; comm. ex Hb. Manil.).

Obs. Affinis M. sundaico Bl., qui differt foliolis subtus reti venarum angustissimo prominulo eleganter notatis, plurifoveolatis, nec non disco anguste annulari glabro.

OBSERVATIONS ON THE LIFE HISTORY OF ASCARIS VITOLORUM, A PARASITE OF BOVINES IN THE PHILIPPINE ISLANDS

PRELIMINARY PAPER

By BENJAMIN SCHWARTZ

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ONE PLATE

INTRODUCTION

The occurrence of *Ascaris vitolorum* in cattle and water buffaloes in the Philippine Islands and the importance of the parasites as serious pathogenic agents have already been emphasized by me.(3) Since the preparation of that paper, studies on the eggs and larvæ of these parasites have led to certain conclusions concerning the effect of sunshine on the embryonated eggs and on the invasion by the larvæ of various organs that are of sufficient importance to warrant their publication at this time. Observations on the development of the eggs are also included.

DEVELOPMENT OF EGGS

The eggs of *Ascaris vitolorum* vary considerably in shape and in size, as shown in Plate 1, figs. 1 to 10. Measurements of about seventy eggs showed a maximum length of 99 μ, a minimum length of 68 μ, a maximum width of 76 μ, and a minimum width of 65 μ. Most of the eggs measured varied from 76 to 84 μ in length and from 64 to 68 μ in width. The majority of the eggs studied were more or less elliptical, although a small percentage of those that have come under my observation were almost spherical.

Under the influence of climatic conditions prevailing in the Philippines in December, January, and February, during which time the approximate average temperature was about 25° C., the eggs, which are unsegmented when expelled from the host, segment rapidly, and within five or six days the outline of the embryo can be distinguished in cultures of eggs kept in Petri

dishes containing a thin layer of 2 per cent formalin (Plate 1, figs. 9 and 10). Formalin cultures ten to twelve days old contain embryonated eggs (Plate 1, figs. 11 and 12), the embryos generally exhibiting sluggish movements.

In common with the behavior of embryonated eggs of other species of *Ascaris,* further development does not take place unless the eggs are swallowed by a suitable host. Occasionally, dead larvæ have been observed in culture dishes, but hatching outside of the host is an unusual occurrence.

The vitality of the eggs of *Ascaris vitolorum* was considerably reduced after two months, during which time they were kept in 2 per cent formalin at room temperature. Although many eggs still showed vitality in response to heat stimulation, they produced very light infestations in experimental animals to which they were fed. Examination of fæces from such experimental animals, two or three days after artificial infection, revealed the presence of numerous embryonated eggs, apparently dead. Whether the eggs normally have a short duration of life or whether the growth of fungi in culture dishes is a factor in shortening their life has not been determined.

Experimental feeding of ripe eggs to rats and guinea pigs resulted in the hatching of viable eggs and the elimination of the eggshells and of undeveloped eggs with the fæces. Empty eggshells eliminated with the dejecta of the alimentary canal were invariably broken (Plate 1, fig. 14), thus proving that the hatching of the eggs is the result of the activity of the embryos, whose escape from the shell involves the rupture of the latter. Undeveloped eggs passed through the alimentary canal intact (Plate 1, fig. 13).

Eggs of *Ascaris vitolorum* do not hatch in the stomach, as the following observations will show. Within two hours after forced feeding of eggs to guinea pigs, numerous unhatched eggs were found in the stomach, hatched and unhatched eggs as well as larvæ were found in the small intestine, whereas most eggs that were found in the large intestine and cæca were undeveloped.

That hatching of eggs is due to the activity of the embryos rather than to the passive effects of the intestinal environment is further shown by the results of feeding to experimental animals old cultures of embryonated eggs many of which were nonviable. After artificial infection with these eggs large numbers of dead embryonated eggs were found in the fæces of ex-

perimental animals, whereas after feeding fully virulent eggs the fæces of the host animal seldom contained embryonated eggs.

Exposure of eggs to tropical sunlight in order to determine the effects of light and heat on the viability of the embryos resulted in the hatching of a number of eggs, as evidenced by the finding of free larvæ and empty eggshells after exposure. Since embryos inclosed in eggshells are stimulated to increased activity under the influence of heat, it may be concluded that the excessive activities to which they were subjected during the exposure resulted in their liberation from the shells.

EFFECTS OF DRYING AND OF TROPICAL SUNSHINE ON EMBRYONATED EGGS

The eggs of *Ascaris vitolorum* are resistant to drying. Eggs were allowed to dry on slides that were kept in shaded places for various periods ranging from several hours to several days, and after being moistened with water they frequently resumed their sluggish movements without further stimulation. In cases in which the embryos showed no movements after being moistened, they were readily stimulated to activity by heat. Eggs similarly exposed on slides to the influence of the sun's rays did not recover after an exposure of one hour. Microscopic examination showed these eggs to be paler than normal eggs and also revealed evidence of internal disorganization of the larvæ.

Further studies on the effects of sunshine on embryonated eggs were made by exposing beakers containing them to sunlight for various periods. The minimum exposure of one hour was invariably destructive to eggs on bright days. After exposure, the eggs were examined under a cover glass. They were not only pale in appearance, but also showed profound internal disorganization and vacuolization, the outline of the embryos being rather hazy and the contents opaque.

In order to determine the effects of light and heat separately, several lots of eggs were exposed in vials, some of which were painted black with India ink, thus shutting out light. A one-hour exposure proved fatal in both blackened and unblackened vials, thus showing that the exclusion of light did not diminish the lethal action of heat.

The vials and beakers used in these experiments were placed on the ground outside of the laboratory, and a thermometer was placed close to the glass containers. The thermometer usually registered 45° C.

It is highly probable that sunshine is responsible for the destruction of eggs of *Ascaris vitolorum* in soil. Sunshine, because of its destructive action on the eggs and larvæ of helminths, is probably an effective natural weapon against depredations of internal parasites. Exposure to sunshine of manure infested with ova and larvæ of helminths may prove effective, at least in the Tropics, in rendering it innocuous so far as concerns parasites.

COMPARATIVE VIRULENCE OF ASCARIS VITOLORUM FOR GUINEA PIGS

Experiments involving forced feeding of embryonated eggs to guinea pigs and rats showed that the effects produced on these animals were generally milder than those produced by the larvæ of *Ascaris lumbricoides*. As a matter of fact, negative post-mortem results were obtained in several cases in which moderate doses of eggs were fed. Extremely heavy doses of eggs fed to guinea pigs produced symptoms of *Ascaris* pneumonia, but deaths were not common. While I know of no accurate method by which to judge the relative effects of eggs of *Ascaris lumbricoides* and *A. vitolorum* on guinea pigs, I have reason to believe, basing my belief on results from experimental feeding of eggs of both species to these animals, that they are more resistant to the larvæ of *A. vitolorum* than they are to those of *A. lumbricoides*, so far as can be judged by recovery following an attack of *Ascaris* pneumonia.

OCCURRENCE OF LARVÆ IN VARIOUS ORGANS

Observation on the invasion of the lungs and liver by the larvæ of *Ascaris vitolorum* revealed nothing that differs essentially from the invasion of these organs by the larvæ of *A. lumbricoides*, except that the liver remained parasitized for longer periods in animals infected with the former species.

Larvæ were not found in the blood, which probably was due to the fact that the experimental animals that were examined within a day or two after artificial infection generally proved to be lightly parasitized. This was due in turn to the feeding of old cultures that contained many nonviable embryonated eggs. Larvæ were found in the liver as early as one day after artificial infection, but the lungs and other organs were negative in this early stage of infection.

As has been mentioned the most-striking difference in behavior of the larvæ of *Ascaris vitolorum* and of *A. lumbricoides* is the comparatively longer sojourn of the former in the liver. In a recent paper on the course of migration of *A. lumbricoides*

larvæ, by Ransom and Cram,(2) the following statement with reference to the sojourn of larvæ in the liver occurs:

After the fifth day they are usually so scarce as to be found with difficulty and often none are found even after repeated examination. In the present series of experiments no larvae were found in the liver later than seven days after infection.

Ransom and Cram examined the livers of sixty-eight animals, of which fourteen were examined later than seven days after feeding the eggs. In five cases in which the duration of infection was seven days, only one liver was positive, the infection being light. In fourteen cases in which the duration of the infection was from eight to twelve days, the livers were all negative. I have found the liver of guinea pigs heavily infested with larvæ five days after artificial infection, whereas Ransom and Cram found larvæ in the liver of four out of five guinea pigs during a similar stage of infection, but the larvæ were not numerous. I have found numerous larvæ in the liver of guinea pigs nine days after feeding eggs, and in one case I found the liver heavily parasitized by larvæ thirteen days after feeding eggs. In the last case numerous press preparations of the lungs were made, but no larvæ were found despite the fact that these organs still showed numerous petechial hæmorrhages characterestic of *Ascaris* pneumonia. Guinea pigs examined nine days after feeding eggs usually contained more larvæ in the liver than in the lungs, so far as could be judged by the relative abundance of the parasites in these organs as seen in press preparations.

It appears evident, therefore, that the larvæ of *Ascaris vitolorum* sojourn in the liver of guinea pigs for a relatively long time. The fact that they are still abundant in the liver after the lungs have become free from them indicates that larvæ of *A. vitolorum* are arrested in the liver in heavy experimental infections, and that many of these larvæ probably fail to reach the lungs. Further studies on this phase of bovine ascariasis in experimental animals are in progress.

In heavy experimental infections larvæ were also found in the spleen, pancreas, kidneys, and heart cavity nine days after infection. The kidneys were heavily infested, and larvæ were found in the cortical as well as in the medullary portions. The presence of larvæ of *Ascaris lumbricoides* in the kidneys was overlooked in the earlier studies on the migrations of the larvæ. Yoshida(4) and Fülleborn(1) found them in these organs.

The guinea pig whose liver was heavily infested thirteen days after feeding eggs failed to show larvæ in the lungs, kidneys, spleen, pancreas, blood vessels, and spinal fluid.

SUMMARY

The observations recorded in this paper may be summarized as follows:

1. Eggs of *Ascaris vitolorum* were observed to develop rapidly under the influence of tropical conditions, and many contained embryos in about ten to twelve days.
2. Ingestion of embryonated eggs by experimental animals resulted in the hatching of the embryos in the intestine and the elimination of undeveloped eggs and of dead embryonated eggs with the dejecta from the alimentary canal.
3. Hatching is apparently the result of the activities of the larvæ under the stimulus of body temperature and probably also of the general intestinal environment.
4. The eggs of *Ascaris vitolorum* can withstand drying if they are protected from the direct rays of the sun. Dry and moist eggs are rapidly destroyed by tropical sunlight, the destructive action being independent of the light rays. The temperature under which these experiments were carried out was 45° C.
5. The larvæ of *Ascaris vitolorum* were found to linger in the liver of guinea pigs for longer periods than the larvæ of *A. lumbricoides* and were still present in the liver after the lungs had become free from parasites. This appears to indicate an arrest of larvæ in that organ.
6. In heavy experimental infections other organs besides the lungs and liver, notably the kidneys, were heavily invaded by larvæ.
7. Guinea pigs appear to be more resistant to the effects of the invasion of the lungs by larvæ of *A. vitolorum* than they are to the effects of a similar invasion by larvæ of *A. lumbricoides*.

REFERENCES

1. FÜLLEBORN, F. Untersuchungen über den Infektionsweg bei Strongyloides und Ankylostomum und die Biologie dieser Parasiten. Beiheft (5) Arch. f. Schiffs- u. Tropen-Hyg., Path. u. Therap. exot. Krankh., Leipzig 24 (1914) 340.
2. RANSOM, B. H., and CRAM, E. B. The course of migration of Ascaris larvae. Am. Journ. Trop. Med. 24 (1921) 129.
3. SCHWARTZ, BENJAMIN. Ascarid infestations of domestic animals in the Philippine Islands. Philip. Agri. Rev. (1922). In press.
4. YOSHIDA, SADAO. On the migrating course of ascarid larvæ in the body of the host. Journ. Parasitol. 6 (1919) 19.

ILLUSTRATION

PLATE 1

FIGS. 1 to 10. Eggs of *Ascaris vitolorum* in different stages of development, showing variations in shape and size.

11 and 12. Embryonated eggs of *Ascaris vitolorum*.

FIG. 13. Undeveloped egg of *Ascaris vitolorum* from fæces of rat twenty-four hours after artificial infection.

14. Empty eggshell of *Ascaris vitolorum* from fæces of rat twenty-four hours after artificial infection.

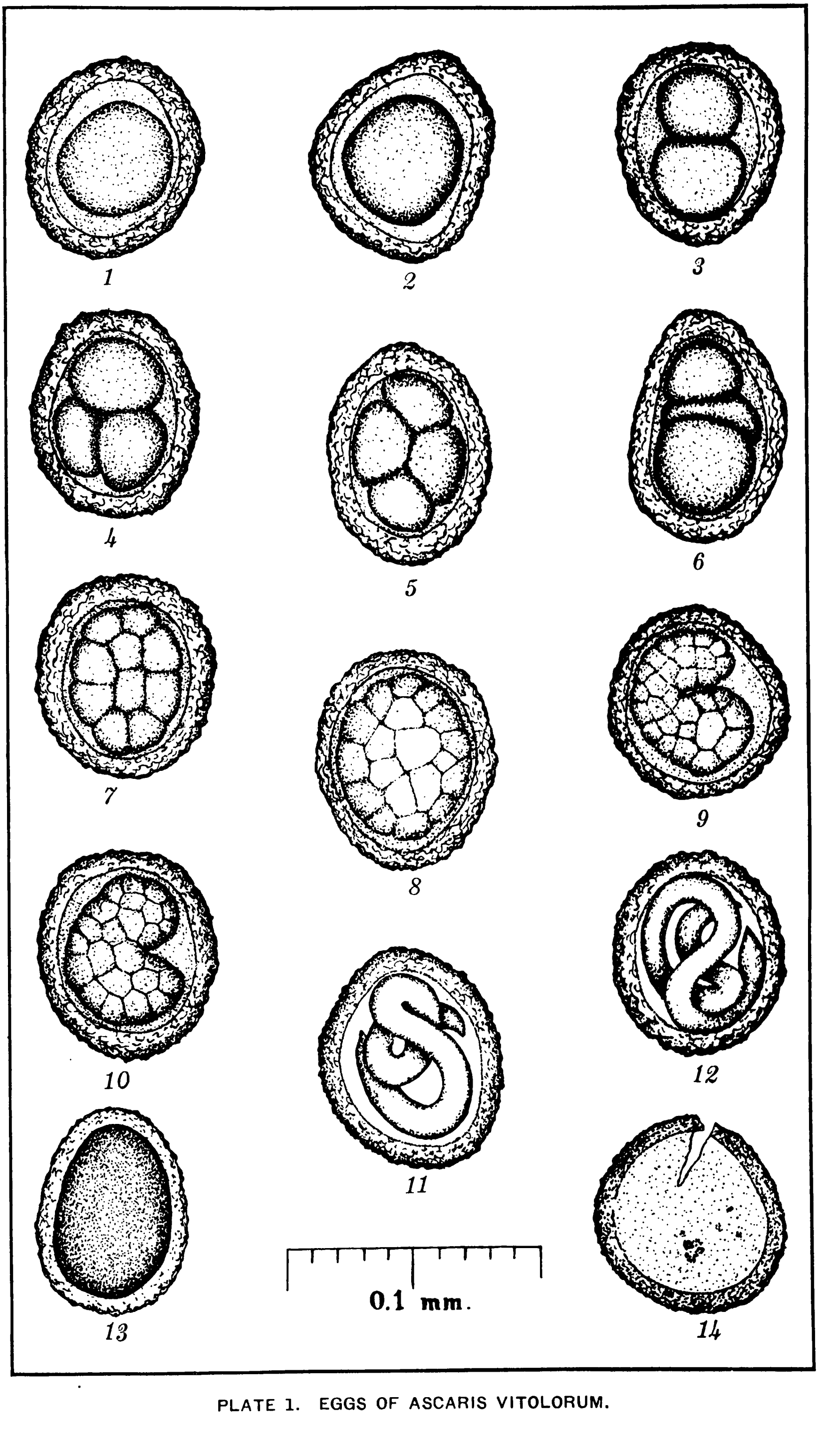

PLATE 1. EGGS OF ASCARIS VITOLORUM.

ERRATA

Volume 19, page 481, line 25, *for* iripides *read* iridipes.
Page 528, line 19, *for* annalis *read* annatis.
Volume 20, page 276, line 24, *for* Poeciloterpa *read* Poeciloptera.

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[New generic and specific names and new combinations are printed in **clarendon**; synonyms and names of species incidentally mentioned in the text are printed in *italic*.]

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